RADIO *and* ELECTRICAL *Review*

TELEVISION — COMMUNICATIONS — SERVICE — SOUND

PRICE 2/3

Incorporating "RADIO and ELECTRONICS"

VOL. 15, No. 8 OCTOBER, 1960

Registered at the G.P.O., Wellington as a newspaper.

Radio and Electrical Review

Vol. 15, No. 8 OCTOBER, 1960

Official Journal of
The New Zealand Electronics Institute (Inc.).
The New Zealand Radio and Television Manufacturers' Federation.
The New Zealand Radio and Television Traders' Federation.
New Zealand Radio, TV, and Electrical Trades' Association (Inc.).

Managing and Technical Director:
W.D. FOSTER, B.Sc.

Subscriptions:
2s. 3d. per copy; 27s. per annum, posted.
Advertising Rates supplied on application.

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"Radio and Electrical Review",
P.O. Box 6361,
Wellington, New Zealand.

OFFICES AND LABORATORY:
48 Abel Smith Street, Wellington.
Radio and Electronics (N.Z.) Ltd.
Telephone: Wellington, 52-343.
Telegrams and Cables:
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SOLE ADVERTISING REPRESENTATIVES for THE UNITED KINGDOM:
Cowlishaw and Lawrence (Advertising), Ltd., Memorial Hall Buildings, 16 Farringdon Street, London, E.C.4. Telephones: City 3718. Cables: Cowlawads, London.

Contents

Sole New Zealand Distributors: Gord on & Gotch (N.Z.) Ltd., Wellington.

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Unhonoured But Not Unsung —A Genius of Electronics

The most recent issue of our contemporary *Wireless World* to come to hand has in it a long article by the well-known technical author M. C. Scroggie on the genius of A. D. Blumlein—and there is little doubt that he was a genius in his chosen sphere—electronic circuitry.

The strange thing about Blumlein and his work is that they are so little known. As Scroggie points out, this was due initially to his remarkably small volume of published technical literature. It is true to say that Blumlein was so busy developing and inventing new things that he had no time to write about them. As a result, many things which could well commemorate his invention of them by being named after him have not been so named, and his brilliant original work is not even dreamed of by many present-day engineers.

No one would claim, for example, that Blumlein "invented" modern high-definition television, but it is true to say that but for him, it would have had to wait several years for its accomplishment. When Blumlein and his team commenced work for E.M.I. in 1935 on the development of the world's first high-definition television system, electronic television could hardly be said to exist at all, and dozens of technical problems had to be solved before it became a reality. It was Blumlein who virtually designed the complete system by thinking out the best form for the composite video waveform which with very minor modifications is still in use today in Britain, and which led directly to the development of almost all the standard television signals that have since been put into operation. Having done this, Blumlein had to find means for making his specification for a television signal into a reality, and at the time, hardly any of the required electronic circuits had been thought of. No one, for instance, had previously built amplifiers with bandwidths remotely approaching those called for by the television system he had "thought up", and it was Blumlein himself who first worked out the now commonplace methods of extending the bandwidth of resistance-capacity coupled amplifiers by means of shunt and series inductors. Those who have difficulty in grasping the need for, and the principles of D.C. restoration in television will appreciate the genuis of one who foresaw the necessity for it, and then developed the methods of accomplishing it that are still the standard ones today! That was just one of the many achievements of this man who literally made television possible in 1936—only about twelve months after he started working on it. He was the first man to appreciate the usefulness of cathode followers in wide-band techniques, and the first to devise a means of providing the saw-tooth scanning currents required by magnetically-deflected cathode ray tubes.

The list could be extended indefinitely without going outside the field of television, yet, before he started work on this, he had already invented two-channel stereophony, as we know it today, and the means for making the gramophone records that twenty years later was re-discovered in America and is now known as the Westrex 45-45 system. The whole thing is down in black and white in British Patent No. 394325, which is 22 pages long and embodies over 70 claims. So much for Westrex!

Before this, Blumlein had made the most notable advances in bridge measuring technique since Maxwell in 1865, but who, today, realizes that Blumlein invented the transformer ratio-arm bridge.

He was killed in an aircraft accident during World War II, while engaged on the development of airborne radar equipment, which again owes more than anyone realizes to Blumlein's genius. Mr Scroggie's article in *Wireless World* is long overdue, as is recognition of one who could almost be called the "father" of modern electronic circuitry.

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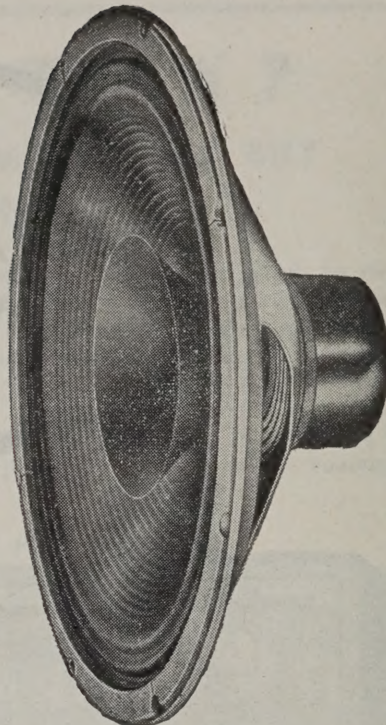

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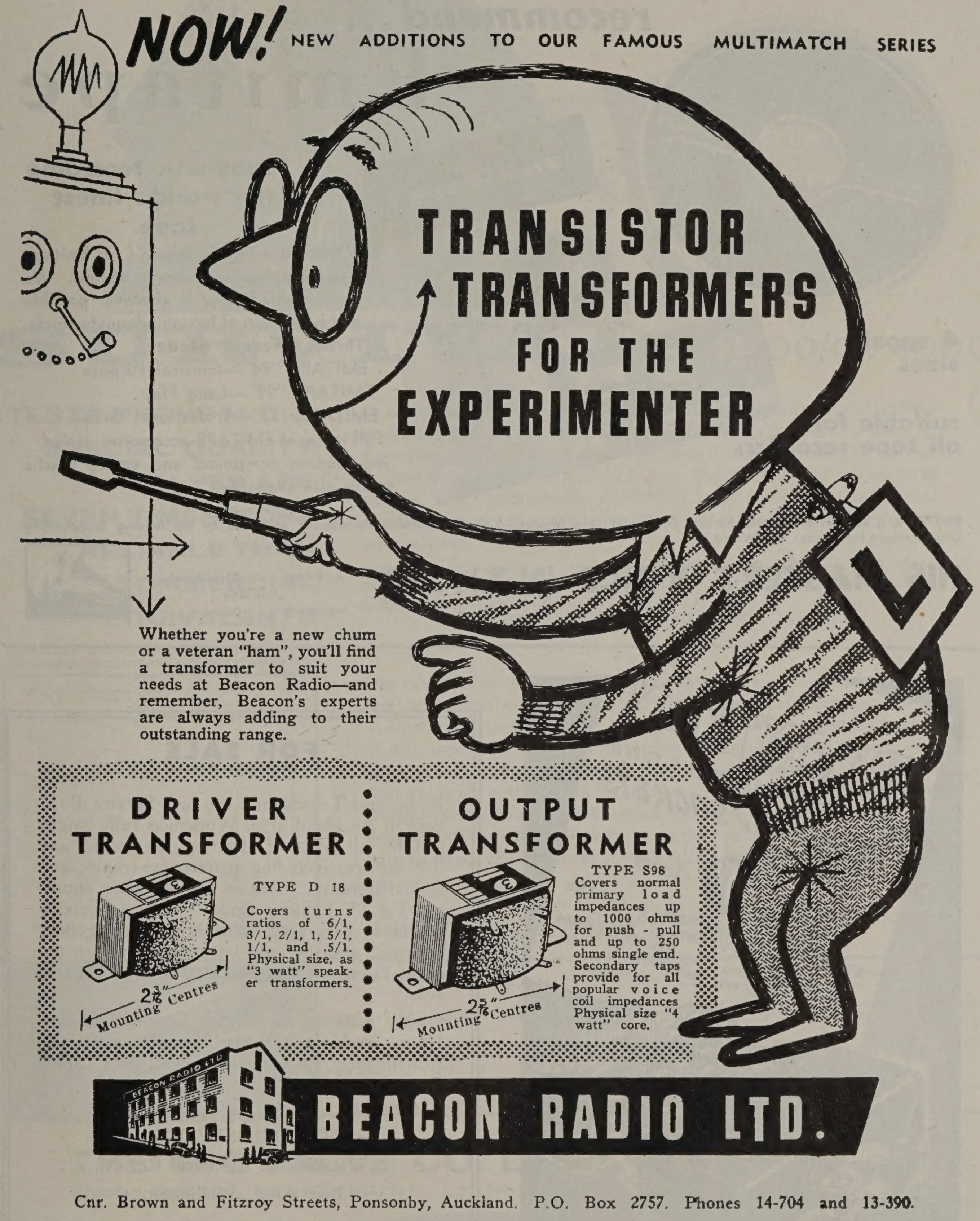
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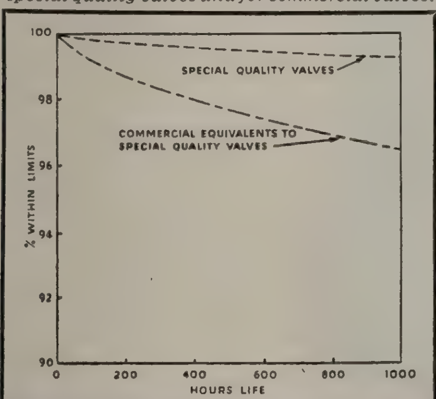
TESTS PROVE M-O.V. SPECIAL QUALITY VALVES ARE SEVEN TIMES MORE RELIABLE THAN COMMERCIAL EQUIVALENTS

In his article (given at the 4th National Symposium of Reliability and Quality Control in Electronics in New York). Mr. R. Brewer* describes the tests carried out on M-O.V. Special Quality valves. In comparing the reliability of these Special Quality valves with that of their commercial equivalents, he states:—" the Special Quality valves are about *seven times better* than their commercial equivalents."

**Research Laboratories of the General Electric Co. Ltd., Wembley. Reprints of Mr. Brewer's article, which first appeared in the April 1958 issue of "British Communications and Electronics", are available on request from the*

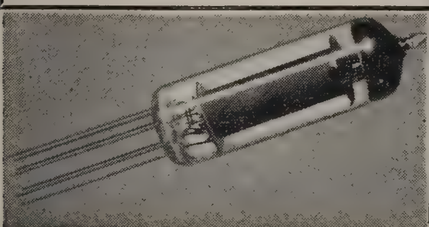
BRITISH GENERAL ELECTRIC CO. LTD.

Percentage within limits curves for M-O.V. special quality valves and for commercial valves.



The table shows in detail the results obtained by the comparative life-testing of special quality valves and their commercial equivalents. Of this and the vibration-fatigue test, Mr. Brewer writes:— "... tests carried out on four types of Special Quality valves have shown a high order of reliability in both types of test. The development of these valves has benefitted from the study of the causes of failures occurring in the life tests of commercial valves. This study has shown how valve assembly, processing and design faults can affect life, and it has thus provided an important feedback path by which improvements in valve reliability have been made."

Comparison between Special Quality valves and commercial equivalents on 500-hour electrical life test.



Type references		Reliable			Commercial		
Reliable	Commercial	No. run	No. outside limits	% outside limits	No. run	No. outside limits	% outside limits
CV4005	U78	1,185	2	0.17	474	9	1.9
CV4014	Z77	1,245	4	0.32	991	22	2.2
CV4062	N78	185	2	1.1	960	22	2.3
	Totals ...	2,615	8	0.31	2,425	53	2.2

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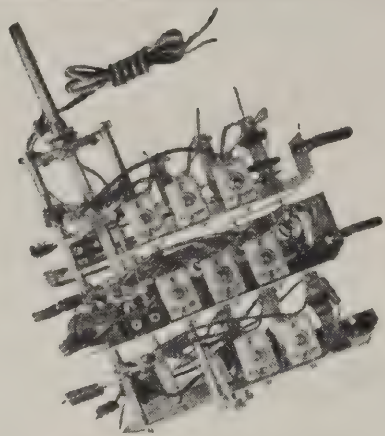

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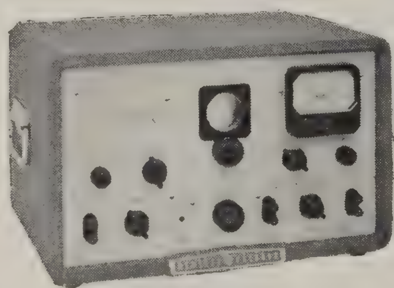

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The Self-healing Characteristics of Metallized Paper Capacitors

Even the best insulating foils have faults, such as minute holes or included conducting particles, so that, in the manufacture of foil-and-paper capacitors, it is necessary to use two layers between opposing electrodes on the assumption that two such faults are unlikely to coincide. This means, then, that the insulation properties are those of a single layer but the separation of the plates is that of two layers, reducing the capacity per unit volume. Metallized paper capacitors were introduced some 15 years ago in an attempt to produce physically smaller capacitors than those manufacured by the foil-and-paper method.

The basis of the metallized paper technique is the application of a very thin coating of aluminium (about 35 millimicrons) to the dielectric tissue itself. The coated foil is then passed between charged rollers so that the current through each fault fuses the surrounding aluminium and prevents contact through the dielectric; the aluminium is converted to aluminium oxide, an effective insulator. Capacitors wound with this treated foil will thus have a much greater capacity for a given volume.

In their initial stages, self-healing, as the fusing of faults is known, occurred in service due to imperfections in materials and processing; however, the current pulses so caused gave rise to no harmful effects in the circuits in which they were then used. In recent years, many improvements have been made, such as lacquering the paper before metallizing, the use of new impregnants, improved processing and automatic control; it is now possible to make certain types of capacitor which show no indications of self-healing during service, the self-healing properties having been fully exploited during manufacture.

The chief merit of the metallized paper capacitor is thus its inherent small size and low inductance compared with oher types and its proved reliability, several types having received Type Approval to Inter-Service Specifications. Moreover, an entry has been made into the high voltage field with Hunt's Types WF311 and WM312 and the new range WF49. High working temperature has also been achieved with the now firmly established synthetic resin solid impregnant and types using this will be the subject of a future Bulletin dealing with their use up to temperatures of 170 degrees Centigrade.

Low-voltage Operation

Some engineers are reluctant to use metallized paper capacitors in low-voltage circuits, fearing that, if a fault were to develop, there would be insufficient energy in the circuit to clear it by self-healing. This argument is based upon a confusion of the two main types of metallized paper capacitor, viz. those using aluminium and those using zinc as the electrode material. It is known that the zinc types, under voltage stress, show a migration of metal through the dielectric from one plate to the other so that a capacitor which was sound can develop a short-circuit in service even under low-voltage conditions. In these types, therefore, it is true that the energy in the circuit would be insufficient to promote self-healing especially since the self-healing characteristics of zinc are inferior to those of aluminium. In the aluminium types, there is no evidence whatsoever of this metal migration so that capacitors which have healed during manufacture show no tendency to develop faults when working at low voltages. This is one important reason for the choice of aluminium for metallized paper capacitors.

To confirm this, life-tests ("Endurance") have been carried out at low voltages and results of one series are presented in Table 1. This table gives the average results of tests on ten capacitors to which 5V d.c. was applied at room temperaure; the tests are continuing and the results are for the first 6000 hours. During the tests, the potential was applied continuously and all periodic measurements, including those of insulation resistance, were made at a voltage of less than 5V to ensure that, if any faults developed under test, the evidence would not be destroyed during measurement. It is noteworthy that there was no incidence of failure under these conditions. Other low-voltage tests have been carried out to confirm these results; these included some at higher temperatures, but, since the system of measurement differed from the standard Inter-Service procedure, the tests are not tabulated and the higher temperature system will be explained in detail in a later article dealing with high-temperature performance. It can, however, he stated, that at 100 degrees Centigrade, there was still no evidence of failure.

The insulation resistance measurements quoted in Table 1 were made at 4.8V and these are relevant to published claims since Table 2 illustrates the fact that, up to the rated working voltages, insulation resistance is virtually independent of test voltage.

Detection of Self-healing Pulses

Freedom from self-healing pulses is important only if these pulses are of sufficient amplitude to disturb the operation of the circuit. There is currently a good deal of conroversy about the maximum permissible value of such pulses, various specifications having been put forward (including that of the International Electrotechnical Commission) with a view to providing a yard-stick for manufacturers' claims. The amplitudes under discussion are 1, 10, 100, and 33mV.

TIME (HRS)	INITIAL			1000			2000			4000			6000		
	I.R. (KMΩ)	CAP. μF	P.F.	I.R. (KMΩ)	CAP. μF	P.F.	I.R. (KMΩ)	CAP. μF	P.F.	I.R. (KMΩ)	CAP. μF	P.F.	I.R. (KMΩ)	CAP. μF	P.F.
Average of 10 Cap.	142	·0446	·0103	116	·0445	·0119	104	·0446	·0114	81·5	·0451	·0095	200	·0445	·0106

TABLE 1 Life Tests at 5 volts d.c., Room Temperature (Type W.97 list No. BM 16)
Variations in recorded I.R. are not significant, since at the low test voltage of 4·8 volts, I.R. readings appear at the extreme maximum of the measurement gear.

Many tests have been conducted in this connection. Firstly, a circuit was set up in which the sensitivity was 1mV and this was used to conduct short-term tests of a duration of two or three hours; these indicated freedom from pulses of this magnitude with type W97 and W197. In addition, an independent user conducted tests of greater duration, i.e., several hundred hours, on equipment with a sensitivity of 300mV at temperatures up to 100 degrees Centigrade; these tests showed a complete freedom from pulses and the user assessed the capacitors as good telephone-grade components.

Another series of tests, based upon one of the specifications, called for a rising voltage (10V/sec.) to be applied through a resistance of 1MΩ until the capacitor broke down, with the proviso that the voltage should not exceed double the rated working voltage. The breakdown was detected by means of a voltmeter arranged to give a direct reading of the voltage across the capacitor. This test was repeated five times, after which a measurement was made of insulation resistance in order to ascertain whether or not satisfactory self-healing had taken place. The results of this test are shown in Table 3 for a series of various types of components. It will be seen that, in most cases, no self-healing pulses occurred up to twice the working voltage. In the remainder of cases, no pulses occurred up to one and a half times the working voltage (the recognized voltage proof-test) and a maximum of two applications was sufficient to raise the spark-free level to double the working voltage. In these latter instances, the voltage was reduced to zero immediately after self-healing had taken place. Obviously, the test does not accomplish the purpose for which it was ostensibly designed since it was plainly anticipated in the proposal that much self-healing would be caused. Nevertheless, the test does show how, once self-healing has taken place at a given voltage, further self-healing up to that voltage is unlikely.

It should be noted that. in order to obtain consistency in tests of these descriptions, and to enable user-engineers to reproduce in their circuits the results obtained in laboratory type-tests, the main cause of variation, i.e. the ingress of moisture, must be eliminated. Moisture is a cause of the necessity for self-healing and it is worth noting that, under the same conditions, a foil-and-paper capacitor, which cannot self-heal, would break down. The engineer would therefore be well advised to use, in pulse-sensitive circuits, capacitors which are well sealed against moisture, the best types in this respect being the Inter-Service Type Approved ranges.

	200V.	150V.	100V	75V.	50V.	37·5V.	25V.	15V.	10V.	5V.
Average	55·8	63·6	68	69·5	73	50·2	57·2	53·4	52	49

TABLE 2 I.R. (KM Ω) versus Test Voltage (Type W.97 list No. BM 16)

Type Approved Ranges

Table 4 presents figures showing the incidence of self-healing sparking as the voltage is increased steadily with types W97 and W197 as well as the ultimate break-down voltages at various temperatures. It will be seen that there is a large margin between ultimate break-down and rated working voltage. Moreover, the continuous sparking which has been taken as a measure of ultimate break-down does not necessarily cause destruction of the capacitors. Where capacity measurements were possible, the proportional loss of capacity due to self-healing was found to be very small.

Conclusion

From the Tables published in this article, it will be seen that the insulation resistance of the test capacitors is well in excess of 200 ohm.farads, the normal published claim for metallized paper capacitors. This is a general feature of these components, the majority

(*Concluded on page* 37)

	INDEX No.	BEFORE TEST I.R. (KMΩ)	BEFORE TEST CAP.	BEFORE TEST P.F.	SELF-HEALING VOLTAGE TEST 1	TEST 2	TEST 3	TEST 4	TEST 5	AFTER TEST I.R. (KMΩ)	AFTER TEST CAP.	AFTER TEST P.F.	TYPE
300 P.F. 750 V.	1	10 000	285	1·00	>1500	>1500	>1500	>1500	>1500	15 000	285	1·00	HUNTS TYPE W.97.
	2	10 000	278	1·00	>1500	>1500	>1500	>1500	>1500	10 000	278	1·00	
	3	10 000	252	0·91	>1500	>1500	>1500	>1500	>1500	10 000	252	0·91	
	4	7 000	252	0·91	>1500	>1500	>1500	>1500	>1500	8 000	250	0·89	
	5	10 000	275	1·10	>1500	>1500	>1500	>1500	>1500	8 000	276	1·00	
	6	10 000	292	1·00	>1500	>1500	>1500	>1500	>1500	10 000	292	1·00	
·005μF 500 V.	7	700	·00491	1·00	920	980	>1000	>1000	>1000	750	·00490	0·98	
	8	600	·00469	0·90	>1000	>1000	>1000	>1000	>1000	700	·00469	0·90	
	9	400	·00527	1·10	>1000	>1000	>1000	>1000	>1000	400	·00527	1·10	
	10	450	·00582	1·05	>1000	>1000	>1000	>1000	>1000	440	·00582	1·05	
	11	350	·00570	1·00	>1000	>1000	>1000	>1000	>1000	350	·00550	1·00	
	12	600	·00505	1·00	>1000	>1000	>1000	>1000	>1000	600	·00525	1·04	
0·25μF 200 V.	13	6·0	·239	1·04	380	>400	>400	>400	>400	6·0	·239	1·04	HUNTS TYPE W.197.
	14	7·6	·235	1·04	>400	>400	>400	>400	>400	7·6	·234	1·12	
	15	7·2	·236	1·10	>400	>400	>400	>400	>400	8·0	·236	1·10	
	16	4·8	·256	1·03	360	>400	>400	>400	>400	8·0	·255	1·04	
1μF 400 V.	17	3·2	0·98	0·86	>800	>800	>800	>800	>800	3·5	0·98	0·86	
	18	3·7	0·96	0·99	>800	>800	>800	>800	>800	4·0	0·96	0·99	
	19	3·7	1·00	0·90	>800	>800	>800	>800	>800	4·0	1·02	0·89	
	20	3·5	0·99	0·95	>800	>800	>800	>800	>800	3·8	0·99	0·95	
	21	3·5	0·95	0·91	>800	>800	>800	>800	>800	4·0	0·95	0·91	
40μF 150 V.	22	·060	39·0	0·90	290	>300	>300	>300	>300	·075	39·0	0·90	HUNTS TYPE W.54.
	23	·105	41·5	0·80	280	>300	>300	>300	>300	·060	41·5	0·80	
	24	·045	41·5	0·80	>300	>300	>300	>300	>300	·045	41·5	0·80	
	25	·090	39·0	0·90	>300	>300	>300	>300	>300	·090	39·0	0·90	

TABLE 3 Effect of repeated d.c. voltage application on I.R. at wkg volts

TEMP.	FIRST* SPARK	INTERMITTENT SPARK	CONT. SPARK	EFFECT OF BREAKDOWN
22°C	302·5	652	850	1 @ 84% CAP.; 1 @ 85% CAP.; 2 HIGH P.F.
35°C	322·5	550	725	1 @ 96% CAP.; 1 @ 94·5% CAP.; 1 @ 90% CAP.; 1 HIGH P.F.
60°C	342·5	800	912	3 HIGH P.F.; 1 BREAKDOWN
75°C	380·0	720	830	1 @ 95% CAP.; 3 BREAKDOWNS.
80°C	405·0	620	787	1 @ 94·5% CAP.; 2 BREAKDOWNS; 1 HIGH P.F.
85°C	322·5	640	807	4 BREAKDOWNS.
90°C	310·0	630	780	1 @ 95% CAP.; 3 BREAKDOWNS.
100°C	332·5	560	757	1 @ 97% CAP.; 3 BREAKDOWNS.
120°C	307·5	520	632	1 @ 100% CAP.; 1 @ 98% CAP.; 2 BREAKDOWNS.

TABLE 4 Breakdown versus Temp. on Hunt's type W.197 (200 V. d.c. wkg)

* Average of four capacitors tested at each temperature. % Capacity refers to Residual Value after Test.
NOTE: No voltage proof given to these capacitors before above tests.

Technology

AN INTRODUCTION TO TELEMETRY

Part 3—Transducers (Continued)

Capacitative and Inductive Transducers

The variable capacitor in one of its many different physical forms can obviously be used as a transducer. Capacitative transducers can operate by alteration of the area of the plates, the distance between them, or the nature or size of the dielectric. For example, placing one plate of a condenser in a fixed position and allowing the other two to move with changes in angular position causes any movement to alter the area between the plates much after the manner of an ordinary variable condenser. The principle is illustrated in Fig. 2-10 in a very elementary way.

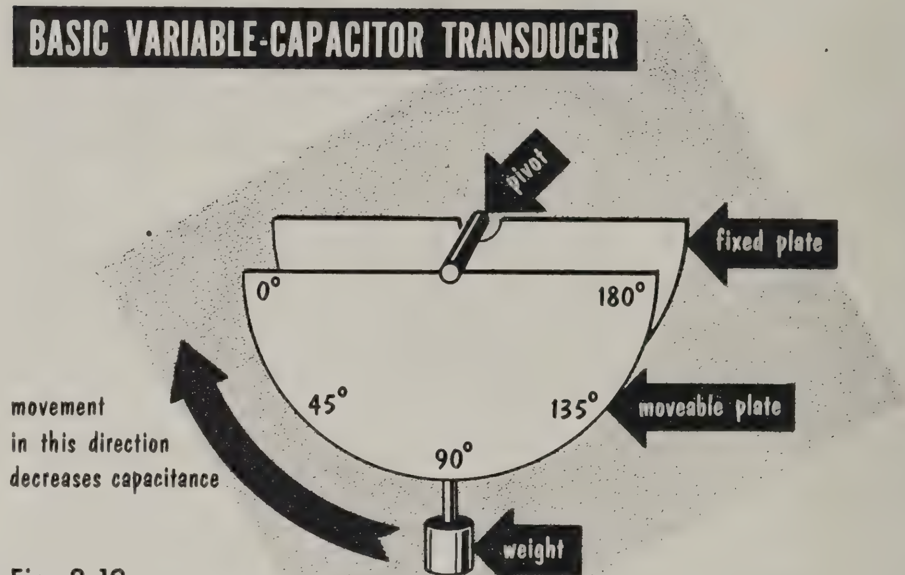
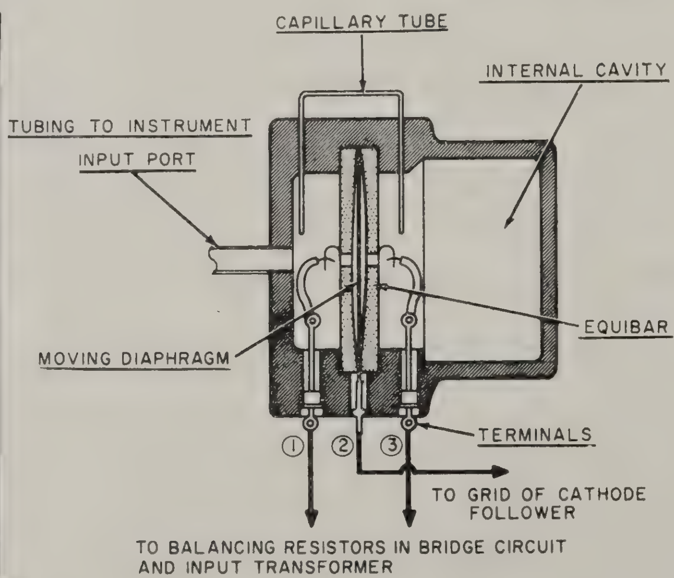


Fig. 2-10



Pressure-Sensitive Transducer Used For Vertical-Speed Measurements

Fig. 2-11

A great advantage of capacitative transducers is that they can be used as part of the tank circuit of an L-C oscillator, when their variations in capacity directly produce frequency modulation of the oscillator without the need for intervening electronic circuits. In all telemetry work, the simplest means of attaining an objective are often the ones to be used because simplicity spells reliability.

An actual capacity-sensitive transducer that is used for measuring velocity in the vertical direction is illustrated in Fig. 2-11. The instrument consists of an "Equibar" pressure sensing unit as a capacitative potential divider in an AC bridge circuit, so that as the pressure decreases on the left-hand side of the diaphragm, the latter moves to the left. The closed cavity at the right-hand side, connected with the left through a capillary tube, causes a reinforcement of the original pressure change, and as the diaphragm moves, it causes a differential change in the capacities between the diaphragm and the fixed elements of the three-terminal condenser.

There are two types of inductive transducer. One of these is the voltage-generating type, but the commonest kind is the variable-reluctance type. They operate either by using fixed coils, and varying part of the iron in the magnetic circuit, or by the reverse procedure. In either case, changes in inductance are

caused, and there again can be used to give direct frequency modulation of a sub-carrier oscillator. In Fig. 2-12 we have a transducer in which pressure changes applied to a twisted tube cause the armature to rotate, increasing the inductance of one coil and reducing that of the other. These coils can be used as arms of a balanced bridge arrangement, where the output increases with movement of the armature from the balance point, and where the phase of the output reverses depending on the direction in which it moves from that point.

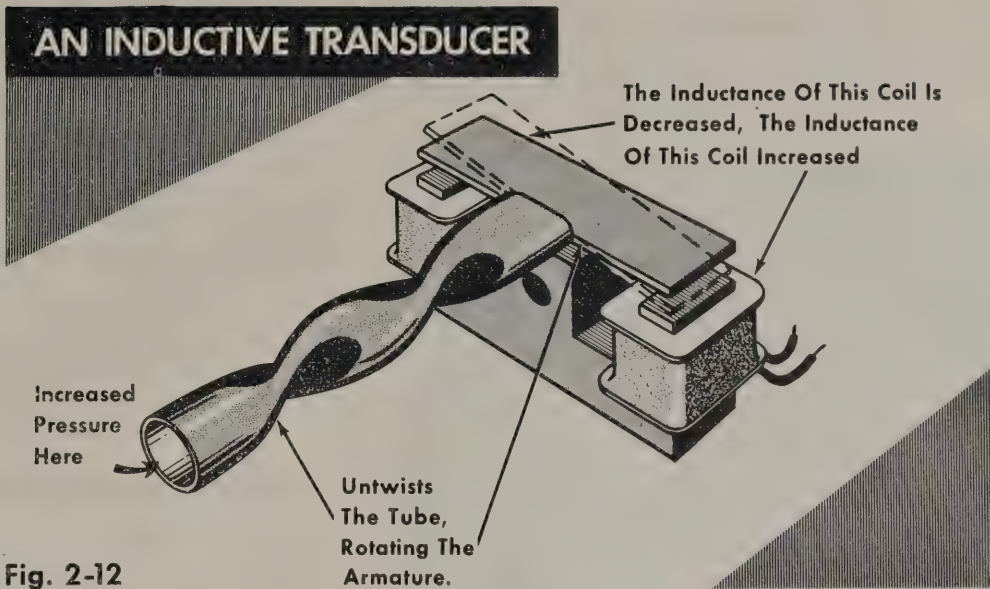


Fig. 2-12

In other inductive transducers, movement of the core can cause simple increase or decrease in the inductance of a coil used as the tank coil of a sub-carrier oscillator.

Sub-carrier Oscillators

Almost any of the well-known varieties of oscillator circuit can be used as sub-carrier oscillators. Some are suited to particular types of transducer, and so are used with that type more often than with others. For example, capacitative transducers are more easily applied to L-C oscillators, because these need only one capacitor to be varied in order to frequency-modulate the output. Resistance-capacity oscillators of numerous kinds can be used, but in general these require that more than one circuit element be varied if frequency modulation is to be secured with a minimum of amplitude modulation.

Multivibrators are frequently used, because their frequency can readily be varied by a direct control voltage, which itself can be obtained simply by the use of a source of potential and a resistive transducer.

Sub-carrier oscillators may have any of the nominal centre frequencies listed in Part 1 of this series, and so may have to work at almost any frequency from 400 cycles per second to 70 kc/sec. As a result, the type of oscillator used for a specific purpose is largely conditioned by the frequency that must be used. This in turn is governed largely by the nature of the modulation that is to be applied to it, as explained earlier. The more rapidly the information to be transmitted varies, the higher the frequencies represented by the modulation, and the higher the sub-carrier frequency that must be used.

It is not always convenient to use a modulated sub-carrier oscillator directly to modulate the final R.F. carrier. For example, suppose we have a 400-cycle

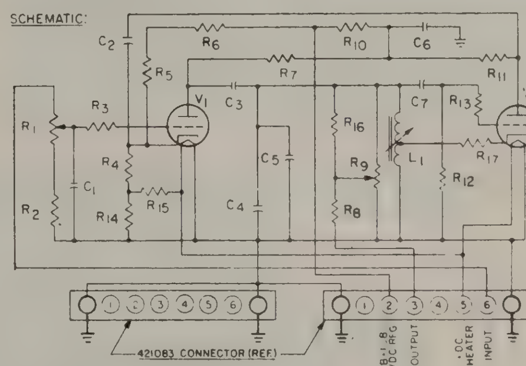


Fig. 2-14

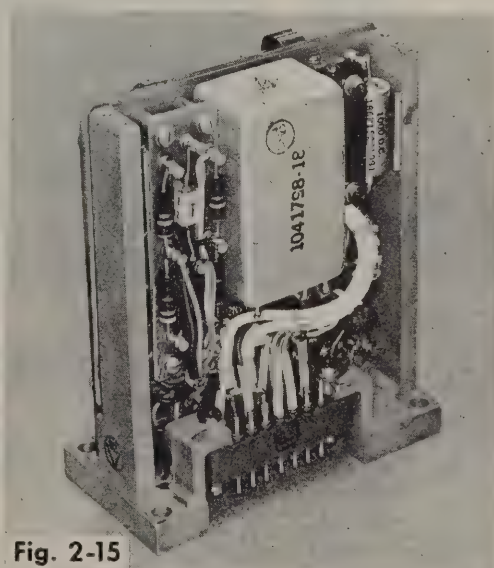


Fig. 2-15

Fig. 2-14.—*Circuit of typical voltage-controlled oscillator.*

Fig. 2-15.—*Physical form of transistorized voltage-controlled sub-carrier oscillator.*

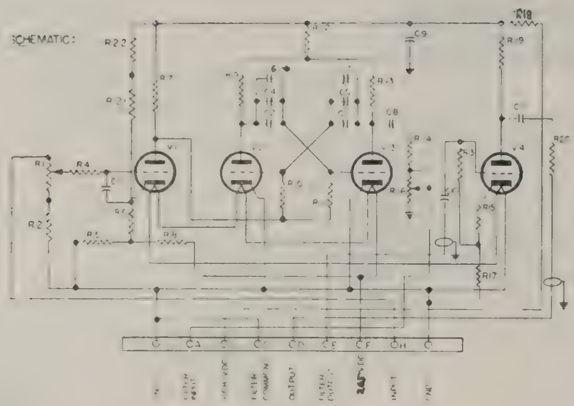


Fig. 2-16

FIG. 2-16.—*Schematic of a voltage-controlled multivibrator for use as a sub-carrier oscillator.*

oscillator, whose frequency may be modulated by plus or minus 10 cycles per second. The final result may be obtained in a number of different ways.

(1) The 400-cycle modulated oscillator may be used to modulate directly a sub-carrier oscillator on Channel 15.

(2) The 400-cycle signal can be made to beat against a 450-cycle fixed oscillator, and the difference frequency, which can thus vary from 40 to 60 cycles per second, can be used to modulate directly a sub-carrier oscillator on Channel 10.

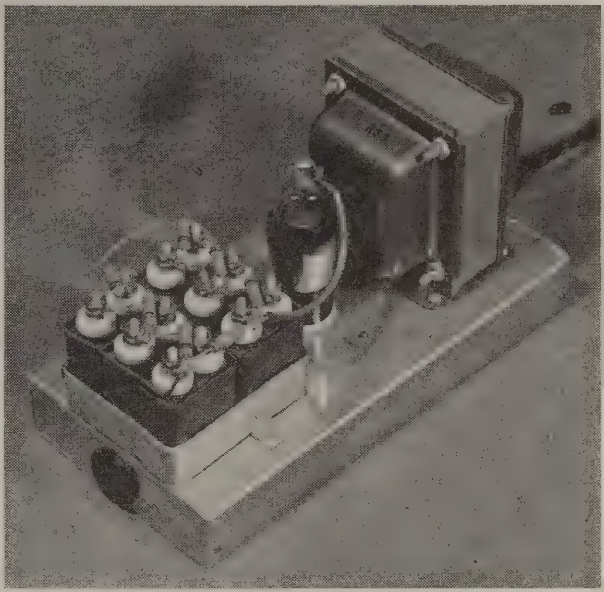
(3) After beating against 450 cycles, the difference frequency of 40 to 60 cycles can be detected and converted into an equivalent DC voltage varying at a rate of less than 1 cycle per second. This may now be used to modulate the sub-carrier oscillator on Channel 1.

(*Concluded on page 37*)

AN EXPERIMENTER'S TELEVISION RECEIVER

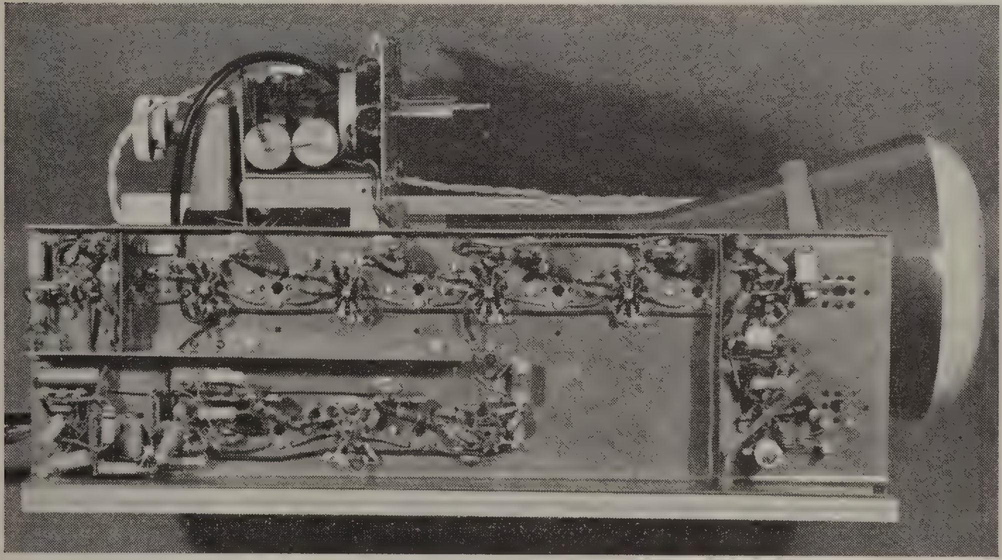
PART 6—Video Amplifier, Synch. Separator, and Power Supply

So far, the portions of the receiver which remain to be specified and described are the video amplifier stage, the synchronizing separator circuit, the sound output stage, and the main power supply. The circuits for all of them are to be found in this instalment, together with notes on their assembly into the complete receiver. Perhaps the easiest way to do this is to describe the power supply arrangements first.



The Power Supply

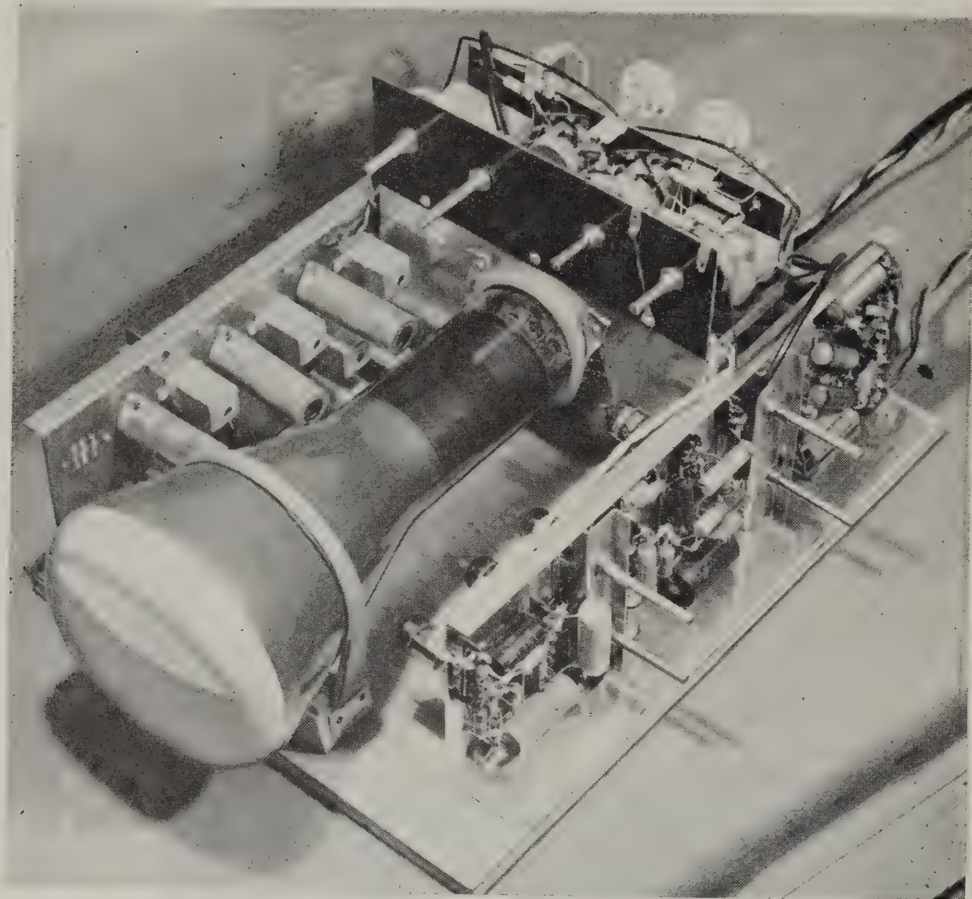
When the circuit drawings for the deflecting arrangements were made, the set had not been completed, and subsequently, we have decided that certain modifications were desirable. These do not involve circuit changes, but only alteration to the voltage supplied to various points on the circuit. If the reader at this point will get hold of his April, 1960 issue of this journal, and a pencil, we will detail the changes to be made. These will then enable the two circuits concerned, namely those on pages 24 and 25 of that issue, to be read in conjunction with the power supply diagram printed in this instalment.



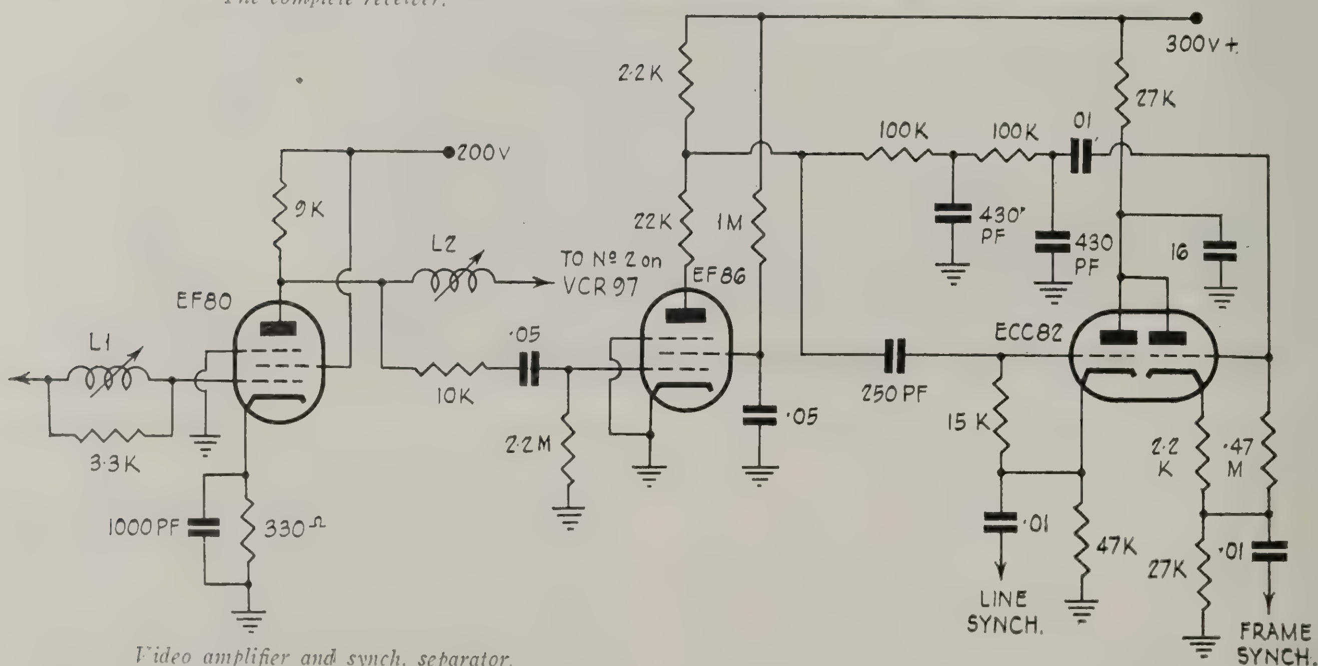
Above is the E.H.T. power supply, and to the left is a view of the completed receiver section of the set.

First of all refer to the diagram on page 24 of the April issue. At the top right-hand corner will be found the legend "+ 300v." Put a line through this, and change it to "+ 400v." Running to the left along the H.T. line thus marked, we come to a 4.7k. dropping resistor. Change this to 10k. 2 watts. This is the only physical change required in the circuit, which is now fed from an H.T. supply of 400 volts instead of the 300 originally specified. What has been done, in effect, is to raise the H.T. voltage on the EF86 line output valves, while preserving the supply voltage for the rest of the circuit at approximately 300, by increasing the dropping resistor.

Now we turn our attention to the frame time-base on page 25 of the same issue. Where the legend "+ 350v." appears, alter this to "+ 400v." Rub out the legend "300v." and add a 4.7k. 1 watt resistor between this point and the 400-volt H.T. supply point. From the point originally marked "300v.", connect an 8μfd. electrolytic condenser to earth. We have now modified both circuits in such a way that they are both fed from the same 400-volt H.T. supply, which will be found on the diagram of the power supply.



The complete receiver.



Video amplifier and synch. separator.

Power for the Tuner and Receiver Section

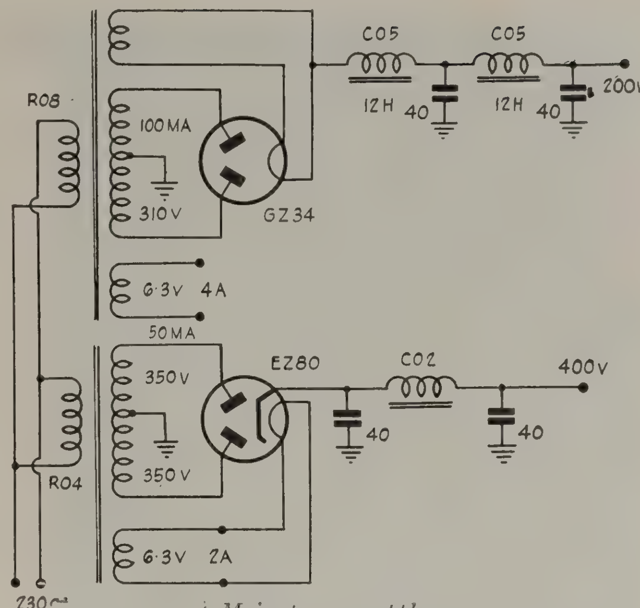
On the original diagrams for the vision I.F. and sound I.F. sections of the receiver, the H.T. voltage was marked as 250 volts. In the interests of keeping down the power consumption of the whole set without materially affecting its performance in any way, it has been decided to reduce the H.T. voltage for the

whole of the receiver portion to 200 volts. It will be noted that a separate power supply has been used for this section, and that the power supply diagram shows two separate supplies, one for 400 volts at some 50ma., and the other for 200 volts at about 100ma. The first uses an EZ80 rectifier and a condenser input filter, following a 350 volt-a-side power transformer, while the second uses a 310 volt-a-side transformer, a GZ34 rectifier, and a choke-input filter. There is nothing special about these power supplies, and any others of similar voltage output and current capacity will do equally well. Since this is an experimenter's receiver, builders will no doubt use their own ingenuity in this department of the set, in making use of equipment that already exists!

Video Amplifier and Synch. Separator

The video amplifier comprises a single stage, using an EF80, directly coupled at the grid to the vision detector, and at the anode, to the cathode of the VCR97. Two peaking coils are used, L_1 and L_2. Both are stock coils by Messrs Inductance Specialists, designed for quite different purposes, but useful here because their inductances make them jsut right for our purpose. L_1 is a type 200A, and L_2 a type 111AV, and both are used as they come, with the tappings being ignored.

The synch separator is a standard arrangement comprising a pentode clipper stage, followed by differentiating and integrating circuits for the line and frame time-bases respectively. The clipper is operated with zero initial bias, and a low screen voltage, and is fed with video signal in negative polarity from the anode of the video amplifier stage. This means that the synchronizing pulses are positive-going, and drive the EF86 into grid current. A negative D.C. potential is thus built up across the 2.2Meg. grid resistor, and this places the video portion of the signal beyond the cut-off region of this valve, so that the output in the anode circuit contains only negative-going synchronizing pulses. The amplitude of these is very large—too large for comfort, actually, so that approximately a tenth of the output is tapped off from the anode load circuit and applied to the inter-synch. separating circuit which follows. For the line time-base, the composite synch. signal is fed to the grid of a cathode-follower, using the left-hand half of the ECC82 in the diagram. The 250$\mu\mu$fd. condenser and the 15k. resistor in the grid circuit differentiate the composite signal, producing positive and negative-going pips from each line pulse. The negative-going pips are reproduced properly at the output, because the cathode follower is zero-biased, while for the same reason, the positive-going ones have almost no effect on the valve, as these only drive it farther into grid current, which it is normally drawing at all times, except during the negative-going synch. pips, which are generated at the leading edges of the synch. pulses.



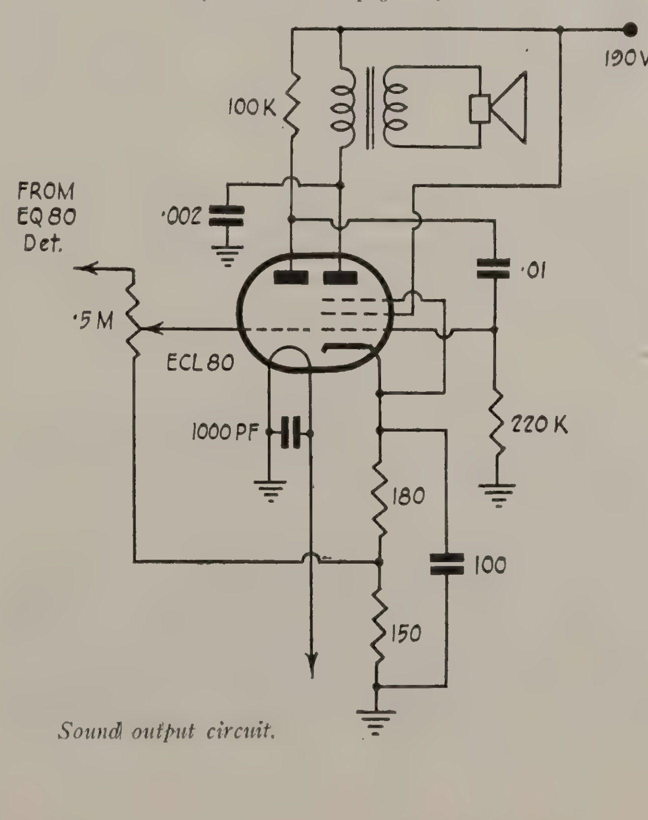
Main power supply.

A double integrating circuit produces negative-going frame pulses during the frame synchronizing signal, and these are passed on to the other half of the ECC82, which acts as a conventional cathode follower buffer.

The Sound Output Tube

This uses an ECL80 to provide about 1 watt of audio power from the pentode section, with the triode being used as a conventional A.F. amplifier stage. The cathode resistor is split, and the grid return of the

(*Continued on page 37*)



Sound output circuit.

AN INTRODUCTION TO THE DIGITAL COMPUTER

This article is intended to provide an introduction to the electronic digital computer and the methods it uses to accomplish its purpose.

Types of Machine

Computers can be divided into two main categories: digital and analogue. The latter converts all the quantities with which it deals into suitable electrical or physical analogies, whereas the digital machine deals with pure numbers as such. The analogue machine can therefore cope with only those problems suited to its built-in analogies while the digital machine can deal with any mathematical problem. Incidentally, the type of machine seen on office desks and usually classed as calculators are really analogue computers; calculus is far beyond their capabilities.

Notation

Man, having ten digits on his two hands, has become accustomed to using the decimal notation, requiring ten states. The computer, however, has only two-fingered (i.e. two-state) circuits and is consequently most easily constructed to work with a notation based upon two, i.e. the binary notation or code. In this, a shift to the left of one place represents an increase in the power of 2 instead of the customary 10. Thus, if $1 =$ one and $0 =$ zero, then $1 = 1$, $10 = 2$, $100 = 4$, $1000 = 8$, $10000 = 16$ and so on. 101 therefore equals 5 and 110 equals 6. If 1 is represented by ON and 0 by OFF, it is easy to see how a row of switches can be made to represent any desired number; switches could, of course, be replaced by any other two-state device, e.g. a trigger pair (of valves or transistors).

Arithmetic

Let us now see how two binary numbers are added together: take the simple sum $1100 + 0111$ $(= 12 + 7)$. First, write the numbers one above the other as usual:

$$\begin{array}{r} 1100 \\ +\,0111 \\ \hline 10011 \end{array}$$

i.e., starting with the right hand column, $1 + 0 = 1$, $1 + 0 = 1$, $1 + 1 = 0$, and carry 1, $1 + 0 + 1$ carried $= 0$ and carry 1 and finally, the last carried figure is placed in the left hand column.

Now simple computer circuits cannot add more than two figures at once, so they cannot carry as they go along. The carry figures are therefore all placed in a store where they wait until the first addition is complete after which they in turn are added in, any resulting carry figures being again stored and added in a separate operation. The machine therefore carries out the same simple sum in this way:

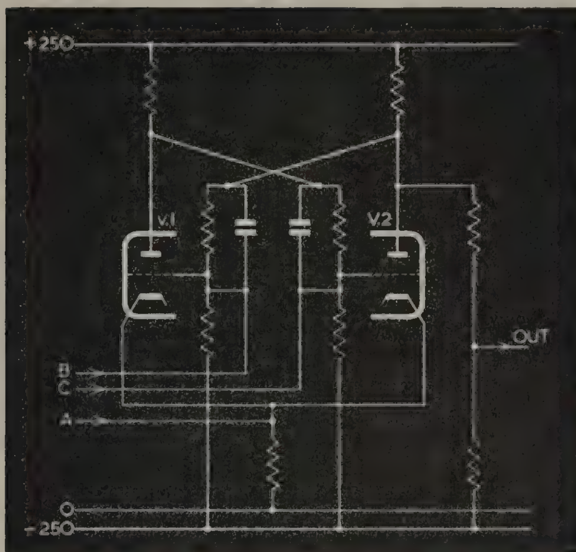
$$\begin{array}{lrl} & 1100 & \\ & +\,0111 & \\ \hline & 1011 & \\ \text{And Carry} & 1000 & \text{which must now added in} \\ \hline & 0011 & \\ \text{And Carry} & 10000 & \text{which is then added} \\ \hline & 10011 & \text{with no carry figures.} \end{array}$$

The lack of carry figures can thus be used to indicate that the process is complete.

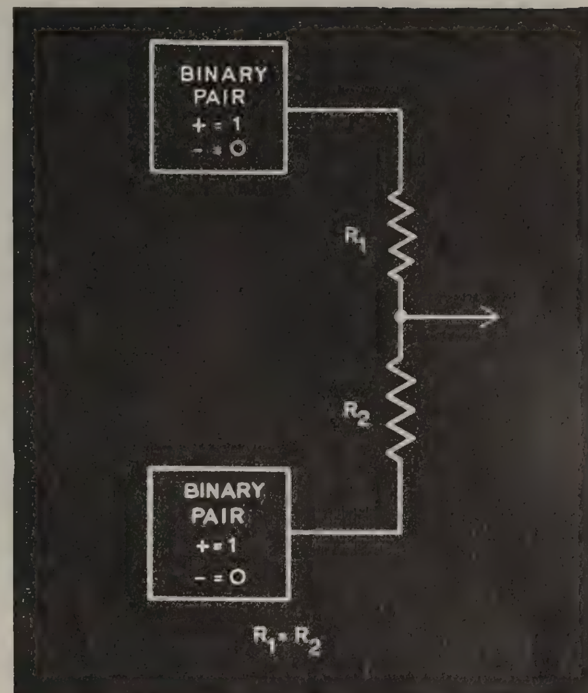
This may seem a very cumbersome way of achieving a simple object. it is! On the other hand, the computer can carry out the series of operations so quickly that it can get away with it. It is like boring the Channel Tunnel with one pick and shovel; if you can work fast enough it is practical. Naturally, much work has been done to speed up the process and several ingenious systems exist (the first one being due to Babbage in the late 18th century).

Now go back to Fig. 1; this circuit can perform a number of functions: assume that, in the OFF state, V1 is cut off and V2 conductive. Then, if a positive pulse is applied to input A, both valves will be cut off for the duration of the pulse after which V2 will be cut off and V1 will conduct; their state will have been changed. Further positive input pulses will cause the state to be reversed each time. Every other input pulse will produce a positive output pulse from the anode of V2 or an anti-phase output from the anode of V1; the circuit thus divides by two. Alternatively, a positive signal applied to input B will set the circuit to the condition where V1 is conductive, i.e the ON state. Thirdly, a positive signal applied to input C will set it to the OFF state. Finally, since both states are stable, the circuit will remain in the state to which it has been set until it is deliberately disturbed, so that it can be used to store a digit. If, therefore, six of these circuits are used, they would be capable of storing a six-digit number, i.e.any number up to $1\ 1\ 1\ 1\ 1\ 1 = 63$. Two sets of six could store two such numbers.

The problem now is to see how the numbers contained in two such sets could be added together. Look again at the addition sum as performed by a crude computer. Three things should be noticeable (1) where the two digits added together in a single column differ, one must be 1 and the other 0, giving the sum 1; (2) where the two added digits are the same, the sum is always 0 and (3) where both digits are 1, there is a carry figure of 1. If, then, we can design a circuit to recognize these three conditions, we can make an adder.



Adder



First, combine the outputs of the two corresponding digit-stores by applying the output from V2 anode in each to opposite ends of a centre-tapped resistor:

The potential at the centre-tap will now be:

+ where both stores contain 1
— where both stores contain 0
zero where both stores contain different digits.

We now have to find circuits which will produce the required outputs from this signal. To recognize a positive signal, we can use a trigger pair in which the input is applied to the grid of that valve which is cut off. Similarly, to recognize a negative signal, we can apply it to the grid of the conductive valve. In each case, the appropriate signal will produce a change of state, neither circuit being affected by the zero-potential signal resulting from a difference in digits.

Now, we are not interested in the — signal resulting from $0 + 0$ since the sum of this is 0. We therefore require circuits which will respond to a positive potential and a zero potential. By shifting the tap on the comparator resistor in Fig. 2 to a higher point, we can arrange that the zero-potential is shifted negatively so that we now have to recognize only negative and positive. When a positive signal is obtained, we wish to place a 1 in the carry register and when it is negative we wish to place a 1 in the sum register. When it is very negative, the negative-conscious circuit would respond, but we can arrange to inhibit this in the presence of the very negative signal by closing a gate responsive to the $0 + 0$ signal.

The sequence of operations now becomes this:

(1) Store the first number in Store A.

(2) Store the second number in Store B.

(3) Connect both Stores A and B to the Adder.

(4) Disconnect the Stores from the Adder, the stable pairs of which will have taken up states corresponding to the required sum and carry figures.

(5) Connect the Adder to Stores C and D which will then take up the sum and carry figures.

(6) Disconnect the Adder from Stores C and D, reset it to zero and connect it to the outputs; the first carry operation will then be carried out.

(7) Disconnect the Adder from the outputs of Stores C and D.

(8) Reset Stores C and D to zero.

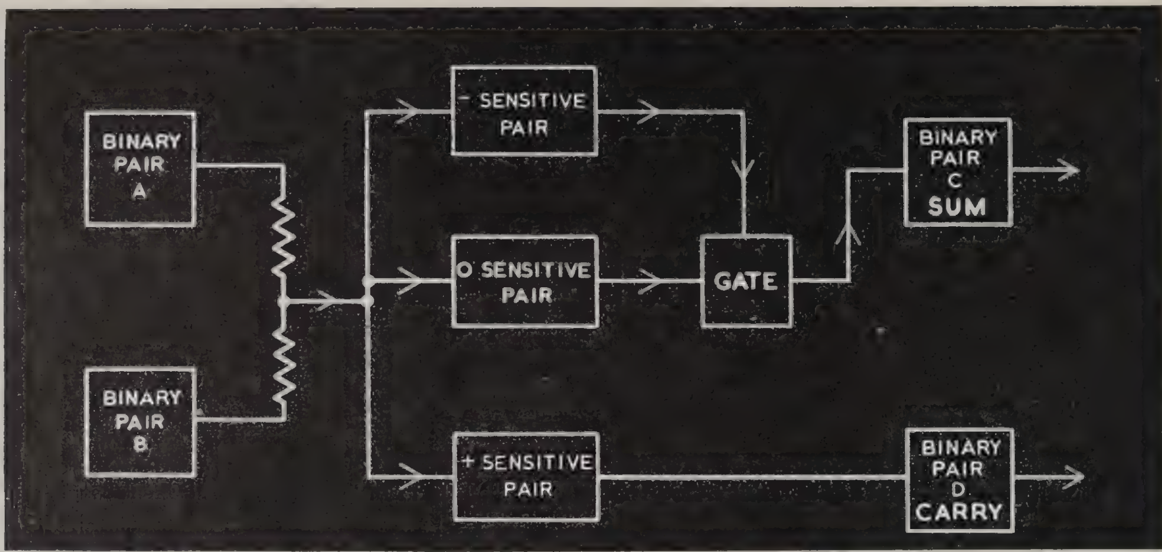
(9) Connect the outputs of the Adder to the inputs of Stores C and D whereupon the second sum and carry figures will be inserted.

(10) Repeat (6) to (9) until no carry figure is obtained.

(11) Connect Store C (containing the final result) to the output indicating device.

(12) Clear the stores and adders except Stores A, B, and C which will then contain the original problem and the answer, ready for any further operations to be carried out upon them.

If there is no need to retain the original problem, the whole process could be carried out by clearing Stores A and B after (4) and using them instead of Stores C and D. With a modern machine incorporating the short-cut devices which have been invented in recent years, the whole process need take no longer than a few microseconds.



Subtraction

This is a very similar process to addition. Look first at a simple binary subtraction:

```
  1100 (  12)
− 0111 (− 7)
```

= 0101 (= 5) i.e., starting from the right hand column, 1 from 0 won't go so borrow 10 from the next column to the left, leaving 1 and carry — 10, repeat for the next column, 1 — 1 = 0, and 1 — 0 = 1 which would be done by the computer as follows:

```
                   1100
                 − 0111
                   ----
                   1011
And Carry Minus    0110  which must now be
                   ----
                         subtracted
                   1101
And Carry Minus    1000  which must again be
                   ----
                         subtracted
                   0101
```

Here again, simple logic circuits must be used similar to those in the Adder but as follows:

If the potential from the combining resistor in the comparator is either + or —, the difference is 0 and the carry is 0. A zero potential produces a difference of 1 to be placed in the difference register. A zero potential where register B is positive requires a carry figure. It is easy to see how the Adder circuit can be adapted for these requirements.

Multiplication

This amounts simply to successive additions, the sequence being:

(1) Place the multiplicand in Stores A and B.

(2) Place the multiplier in Store C.

(3) Add Store A to Store B, clear Store B and place the sum in Store B.

(4) Subtract 1 (one) from Store C.

(5) Repeat (3) and (4) until Store C contains zero, indicating that the multiplication is finished.

(6) Connect Store B to the output indicator which then shows the answer.

Division

This is basically the same process as multiplication except that it is done by successive subtractions instead of additions. In this case, however, it must be arranged that the termination signal is obtained either (a) when the divisor exceeds the remainder or (b) the remainder is less than zero (i.e. a negative quantity) which would be indicated by a carry figure proceeding to the extreme left of the remainder store (try it on paper). If (b) is adopted, then the machine must have in its stores the previous quotient and remainder and will read these out when the remainder goes negative.

Other Computations

Since the basis of all mathematics is multiplication and division, addition and subtraction, we can now undertake the solution of any problem. By providing the machine with detailed instructions on how to deal with the various figures in its stores (of which a sufficient number must be provided) any problem can be solved.

Programming

The compilation of suitable instructions for the machining is known as programming, the sequence of operations being the programme. This calls for the services of a very good mathematician who can think in terms of the machine's capabilities. He then codes

the instructions into a form which the machine can accept, usually punched paper tape. The machine then receives its quantities and instructions from the tape; when it has completed the first operation, it signals the tape-reader which then moves on to the next step and initiates the next sequence of operations and so on until the whole computation is complete.

Built-in Programmes

The same basic problem is likely to occur many times, such calculations as differentiation and integration are examples. It is therefore normal practice to formulate programmes for such calculations and code them into permanent stores in the machine. It is then necessary, in individual programmes, only to give a code instruction saying, in effect, take stock programme number 3 and carry it out, thus saving the programmer much repetitious labour with its attendant risk of error. Some types of calculation occur only in certain fields of work so that it is useful to have pre-set programme stores which can be either cleared or changed. This adds greatly to the versatility of the machine.

Conclusion

We have here, of course, scarcely scratched the surface of the subject of computers, but perhaps we have suggested to the reader the fascination of these machines in which case he may want to read some more authoritative and detailed books on the subject. We can recommend "Automatic Digital Computers" by M. V. Wilkes and "Arithmetic Operations in Digital Computers" by R. K. Richards. These will give a good idea of the development of the machines and the circuitry encountered.

MOST ADVANCED U.S. TELEVISION WEATHER SATELLITE BEGINS WORK AS PART OF COMPLEX SYSTEM

The United States' new TIROS satellite, carrying the nation's most advanced space-borne television "eye" to study the world's weather, is the information-gathering element in a complex satellite-and-ground system developed for the U.S. Government by the Radio Corporation of America.

The satellite comprises perhaps the most elaborate electronics package yet sent into orbit around the earth, containing specially-designed miniature television cameras, video tape recorders, transmitters, solar cell and rechargeable battery power supplies, and an array of control and communications equipment.

Speeding along its course in space, the satellite is linked to an extensive ground network of tracking and receiving stations, data-processing systems, and programming and control centres. Together, the satellite and ground equipment form a unified system to gather and analyse world-wide data on cloud formation in the earth's atmosphere.

The TIROS system, including the satellite and its associated ground network, was designed and constructed by scientists and engineers of R.C.A.'s Astro-Electronic Products Division at Princeton, N.J., under the general systems management of the National Aeronautics and Space Administration and the technical direction of the United States Army Signal Research and Development Laboratory at Fort Monmouth, N.J. It evolved from the original concept of Vanguard II, a weather satellite developed by the Army Signal Corps for NASA.

Dr Elmer W. Engstrom, Senior Executive Vice-President of R.C.A., described the system today as "a major achievement in space technology and in electronics for space."

He said "the success of TIROS stands as a tribute to the vision and skill of scientists and engineers in the government and military services, in universities, and in industry. As the prime contractor to the government in the TIROS programme, R.C.A. is proud to have borne a major part in translating this inspiring concept into a practical system of such immense significance to us all."

The importance of the TIROS system as a new experimental tool for meteorologists was emphasized by Barton Kreuzer, Manager, Marketing, of the R.C.A. Astro-Electronic Products Division, who said:

"The mission of the TIROS satellite is the visual observation of cloud formations over large portions of the earth to produce new information about such weather phenomena as hurricanes, typhoons, and the movement of weather fronts. Besides providing unprecedented and comprehensive visual coverage of global weather on a swift and continuous basis, the satellite will give meteorologists for the first time a means of checking the accuracy of present weather reporting from ground stations around the world. Thus, it promises not only to lay the groundwork for new satellite weather services in the future, but also to increase the effectiveness of present world-wide weather information gathering methods."

The path of the satellite, circling the globe from west to east about every 90 minutes at an altitude of about 400 miles, will permit cloud observations throughout a belt extending from the latitude of Santa Cruz, Argentina, in the south, to the latitude of Montreal, Canada, in the north. During its planned operating lifetime of 90 days, the satellite is expected to complete about 1,300 orbits, covering every part of this belt many times.

Sequence of Operations is Described

According to Sidney Sternberg, Chief Engineer of the R.C.A. Astro-Electronic Products Division, the operation of the system involves the following sequence of three principal functions carried out by an intricate combination of electronic sub-systems in the satellite and on the ground:

(1) Preparation of a programme and transmission of commands to the satellite at the start of each orbit, including instructions for picture-taking in specific areas of interest to the meteorologists.

(2) Operation of the television and other equipment in the satellite during its passage, in response to the control commands received from the ground.

(3) Read-out of the pictures and other information from the satellite on command from the ground at the completion of each orbit.

The principal ground stations are situated at Kaena Point, Hawaii, and Fort Monmouth, N.J. During all but three or four orbits each day, the satellite pases within range of one of the stations, permitting read-out of information and programming of the satellite electronic apparatus for the next passage. In addition, two "back-up" stations are situated at the Space Centre of R.C.A.'s Astro-Electronic Products Division at Princeton, and at Cape Canaveral, Florida.

The satellite itself was described by Mr Sternberg as "a major space system complex" incorporating advanced concepts in space communications and the remote control of satellite functions. He pointed out that its development had required not only the design of new miniaturized television equipment and control

devices, but also special methods of controlling the satellite's rate of spin, its attitude in relation to the earth's surface, and its thermal balance during the 90-day period. He gave the following summary of its principal features:

Shaped like a drum 42 inches in diameter and 19 inches in depth, the vehicle is covered on its top and sides with over 9000 solar cells which generate electricity directly from sunlight to charge an assembly of small storage batteries that power the electronic equipment.

Has Two Complete TV Systems

The key function of the satellite is performed by two complete television systems capable of taking a series of still pictures of cloud formations during each orbit. Each employs a specially-developed R.C.A. half-inch Vidicon camera small enough to hold in the palm of a hand. One of the cameras is equipped with a wide-angle lens for viewing clouds in an area about 800 miles on each side. The other employs a narrow-angle lens to scan cloud details in a smaller area.

Linked to each camera is a miniature television magnetic tape recorder specially designed by R.C.A. engineers for satellite use. Each of the recorders stores up to 32 individual pictures taken by the camera during a single orbit. When the satellite passes within range of one of the ground stations, a command signal causes the information to be read from the tape into the satellite transmitter for transmission to the earth. For picture-taking while the satellite is within range of the station, the cameras can be instructed to feed their information directly to the transmitter rather than to the tape storage sysems.

To permit meteorologists to identify the direction of each picture, the satellite carries a "north indicator" system which automatically measures the angle of the sun in relation to the vehicle. The resulting signal, sent to the ground with each picture, is processed by a "sun angle computer" and displayed on a television screen beside the picture to indicate the north direction of the image. In addition, an infra-red detector on the satellite senses the crossing of the earth's horizons as the vehicle rotates at its spin rate of 12 revolutions per minute. This information also is transmitted to the ground and is processed to determine the attitude in space of the vehicle at the time of picture taking.

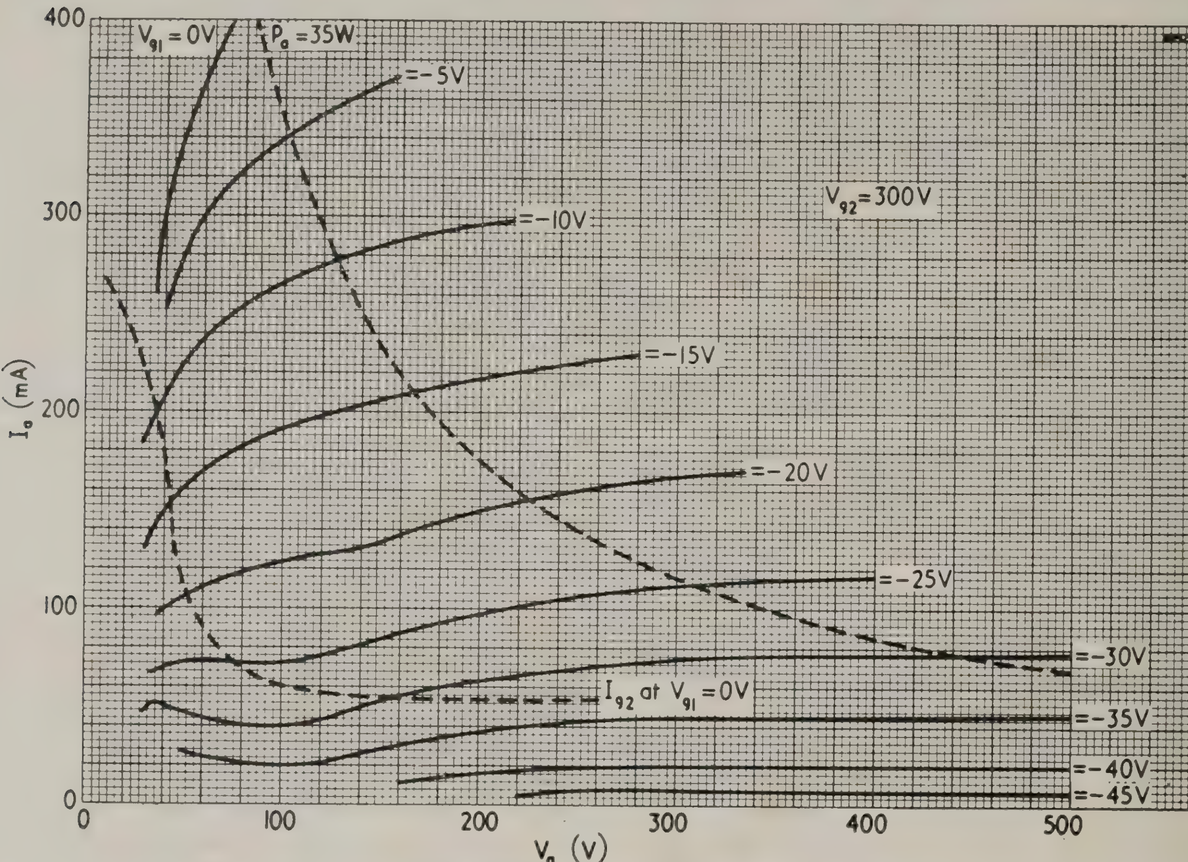
At the start of each orbit, the television cameras can be instructed electronically to photograph an area of specific interest—such as a typhoon centre over the Pacific or a hurricane in mid-Atlantic. The instructions, prepared at the NASA Computing Centre in Washington in co-operation with specialists of the United States Weather Bureau, are sent to the ground stations. At the appropriate station, the programme is sent in the form of radio signals to an "electronic clock" in the satellite. The clock stores the instructions somewhat in the fashion of a remotely operated alarm clock, causing the cameras to start a sequence of operations at the specified time during the succeeding orbit, as the satelliet passes over the region of particular interest.

As the satellite swings around the earth and comes again within range of a ground station, a command signal is sent from the ground for transmission of the cloud cover pictures stored on the tape. At the ground station, the information is displayed on a television picture tube and recorded on another magnetic tape system. The image on the picture tube also is photographed for further study and future reference by experts of the Weather Bureau and other services.

Mr Sternberg pointed out that the ground command and control system has been designed by R.C.A. engineers to permit either automatic or manual operation of the satellite system, or a combination of both. With automatic operation, the programme for the orbit is pre-set and each step is started by the electronic clock control in the satellite. With manual operation, the commands are transmitted by an array of push-buttons at the ground station, permitting direct operation of the television cameras while the satellite is within range, and providing an opportunity for checking individual satellite functions. By combining the two methods, the programme is pre-set, but each sequence is started manually by push-buttons at the ground station when the satellite is within range. According to Mr Sternberg, this combined method will be used during the first few orbits of the satellite.

The TIROS system, including the satellite and its associated ground complex, was developed by Astro-Electronic Products Division engineering groups working under Vernon D. Landon and Edwin A. Goldberg, Project Managers.

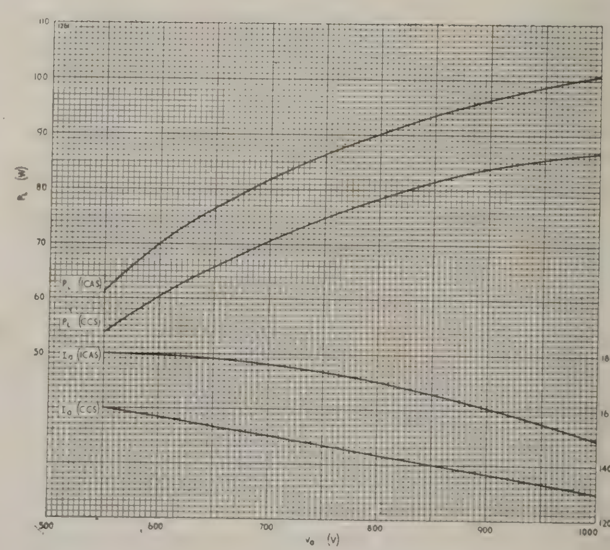
The TT21 and TT22—Two New R.F. Valves For the Transmitter



Anode current curves at V_{g2} = 300V and V_{g1} negative.

Recently announced as available in this country by British General Electric are two new transmitting valves, the TT21 and TT22. These should be of great interest to amateur transmitters and others, as a single valve is able to accept more than the official 100 watts input at all frequencies up to 30mc/sec. Both are based in their design on the now well-known audio valve, the KT88, but the TT21 and TT22 have been built specially for radio frequency service. They are identical in characteristics except for their heater voltages of 6.3 and 12.6 respectively, and their exceedingly modest price will make them almost a "must" for new transmitter designs, whether for conventional C.W. or A.M. transmitters, or for S.S.B. work. The curves reproduced here from the complete data supplied to us by B.G.E. give a good if brief idea of their

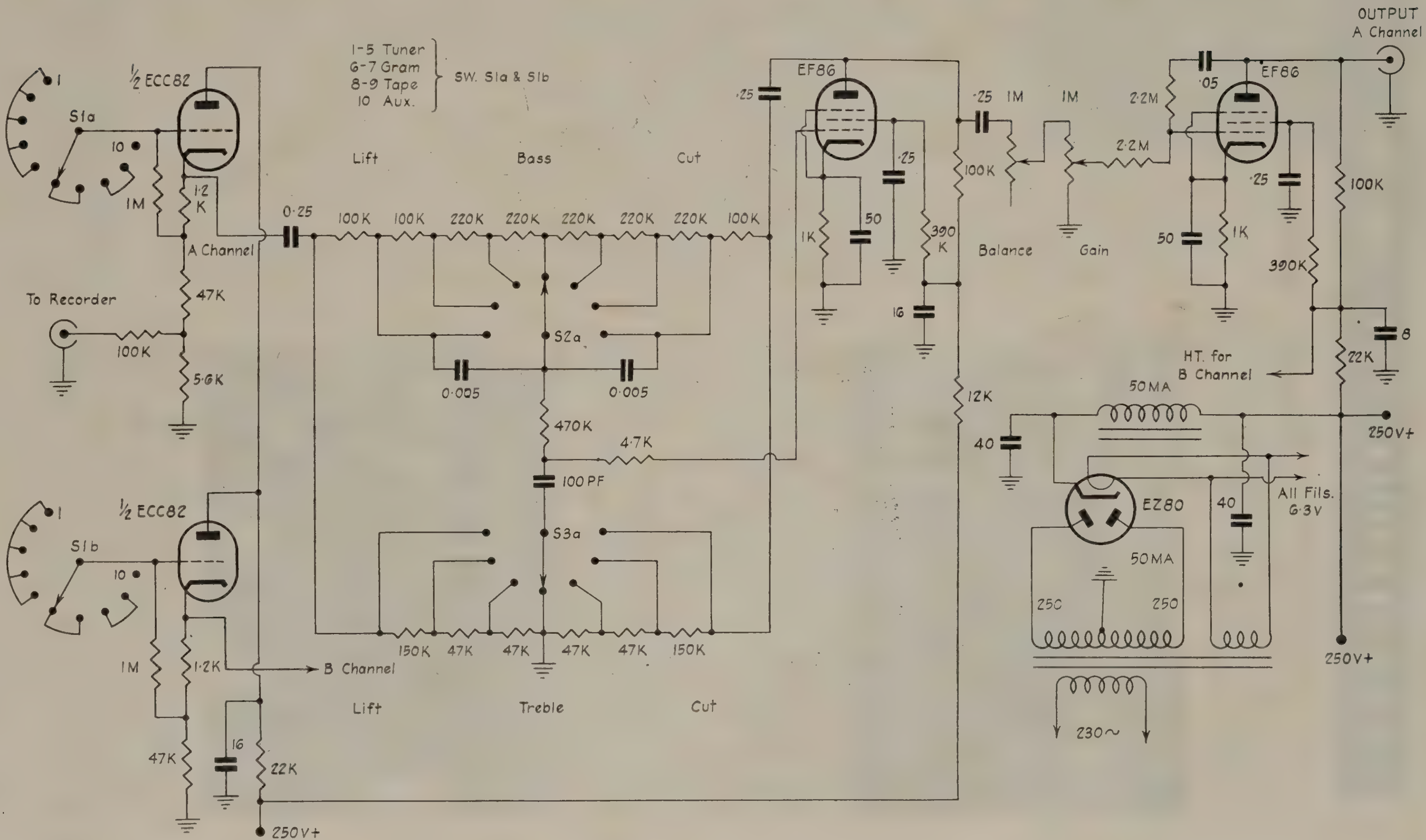
(*Concluded on page 37*)



Anode modulator class C telephony.
Power output/anode voltage curves.

THE "R. & E." COMPREHENSIVE AUDIO SYSTEM FOR HOME USE

We take this opportunity of correcting a series of misfortunes which befell the diagram which appeared on page 27 of our last issue. One of these occurred in the block-making process, and at the same time we found two circuit errors which have been rectified in this re-printed version of the circuit.



ELECTRICAL AND TRADE SECTION

TRADE WINDS

A.W.A. AT THE HUTT VALLEY INDUSTRIES FAIR

The A.W.A. stand at the Hutt Valley Industries Fair, August, 1960. Very appropriately A.W.A., the company which manufactured the equipment used by the New Zealand Broadcasting Service in their broadcasts from the show building, shared the stand with the N.Z.B.S. The photograph shows the 2YD announcer's desk on the left-hand side of the stand. The television camera is hidden behind the A.W.A. symbol. The lens takes its view through a hole which is difficult to detect, in the centre of the A.W.A. symbol. A.W.A.'s part in X-ray and technical training and the depth of the company's activities in the manufacture and supply of specialized equipment are illustrated in the display.

One of the most interesting and striking displays at the Hutt Valley Industries Fair, August, 1960, was the A.W.A. stand—shared with the N.Z.B.S. Commercial Station 2YD. Appropriately the equipment used for these broadcasts, from control unit to transmitter, was manufactured and supplid by A.W.A. to the N.Z.B.S. against a recent contract. Crowds watched the radio announcer at work in the foreground and participated in "See Yourself on Television" in the background.

PERMALI FOR WORLD'S LARGEST V.L.F. TRANSMITTER

The world's most powerful very low frequency radio transmitter is being equipped with Permali densified wood variometer and helix coil supports.

This transmitter is now under construction for the U.S. Navy near Cutler, Maine, U.S.A., and is designed to communicate with submarines submerged as deep down as 100 ft. It will operate on a frequency of 14 to 30 kilocycles beaming out radio waves up to a mile in length and audible to surface ships and shore stations around the world. These signals can be picked up by submarines without the necessity of sending an antenna-bearing periscope above the surface and consequent risk of detection.

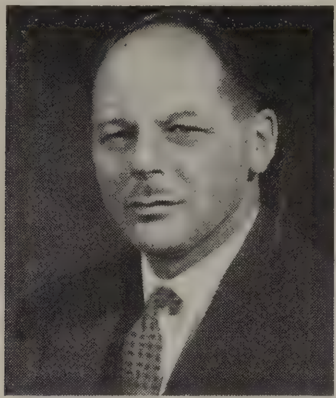
The role of Permali Ltd. in this £20 million project has been, as a sub-contractor to the Continental Electronics Manufacturing Company of Dallas, Texas, to part-design and engineer the complete fabrication of strong, lightweight, dielectric supports for two variometers and two helix coils. The mechanical properties of the Permali insulating wood laminates used can be adjusted to order and the most suitable grade for each part has been selected to give maximum strength in the direction required. All the structures are assembled with nuts, bolts and dowels made from the same non-metallic material.

Each variometer consists of a rotor and a stator to provide variable inductance for circuit tuning and measures overall $21\frac{1}{2}$ ft. high, 13 ft. long, and 12 ft. wide. The rotor, supported by a specially designed tube of approximately 12 in. diameter, and enclosed by the stator structure, carries approximately 4,000 lb of 3.4 in. cable, and is so designed that the angular distortion during operation will not exceed 10 minutes of angle. The stator, likewise, is wound with 3.4 in. cable, weighing some 5,000 lb.

Each helix coil support measures 34 ft. high and 22 ft. diameter, carries 25,000 lb of cable, and provides a fixed inductance in the transmitter circuit. They consist of 12 Permali box-design columns erected in a circular pattern and jointed at several points with tie-braces to give rigidity to the load-bearing members.

All the structures were manufactured by Permali Inc., Mount Pleasant, Pa., U.S.A. in close technical co-operation with the parent company Permali Ltd., Gloucester.

DR STRAKER APPOINTED DEPUTY MANAGER, RADAR DIVISION



The appointment is announced of Dr T. W. Straker, M.Sc., Ph.D., as Deputy Manager of Marconi's Division, of which Mr E. N. Elford, O.B.E., A.M.I.E.E., is Manager.

A New Zealander by birth, Dr Straker had a distinguished career in the New Zealand Artillery during the war, and was captured in the Western Desert and sent to a P.O.W. camp in Italy, from whence he escaped to Switzerland. At the end of the war he returned to New Zealand and lectured in physics for a while, before going to Cambridge, England, to study research into the ionospheric propagation of low frequency waves. Later he joined the Defence Research Board of Canada, and ultimately became head of the division comprising low frequency, high frequency, and microwave groups, working on air defence problems. In 1954 he was appointed Defence Research Liaison Officer, Canadian Joint Staff in London, liaising with U.K. Government establishments and industry on electronics research and development, and air defence. He also spent some time at the SHAPE Air Defence Technical Centre, in The Hague.

Dr Straker joined Marconi's in 1957, and from 1959 until his present appointment was Chief of Project Co-ordination Group, Research Division.

* * *

GOVERNMENT TV POLICY: VIEWS OF A.N.Z. BANK

The A.N.Z. Bank, in its quarterly survey has criticized the Government's policy for the development of television in New Zealand.

"Because television will be costly for New Zealand, the Government is limiting the cost by various controls on the pace and extent of development, but at the expense of depriving the community of the full service to which it should be entitled," says the survey.

"There is a strong case to establish full-scale television service in New Zealand, but New Zealand has some unique disadvantages which make television relatively costly.

"Some main effects of the Government policy are to concentrate capital costs of establishment on the Government itself, to restrict the appeal to advertisers by limiting the audience, and thus to restrict revenue from that source."

"This means that licence fees and sales tax are the major offset for Government expenditure, and these will also be restricted for some years by the import quotas and the limited coverage by low-powered transmitters."

"Furthermore, the small scale of the manufacturing industry, and attempts to establish local manufacture of more components as soon as possible will mean high costs of production per unit."

"A very different picture would emerge," says the bank, "if the Government had taken a different policy line, allowing private enterprise to enter the industry and offering licences for an additional channel in the main centres if such were sought."

"In such circumstances," the bank says, "the Government's licence and sales tax revenue would be augmented without any extra costs and advertising revenue might be raised because the larger audience would justify higher rates."

"If New Zealanders are fully employed and earning high incomes, why should they be denied the right to choose the way they spend their incomes in a free market? The Government may tax such pleasures, and limit the overall level of activity and the amount of credit available, but further interference infringes the citizens' economic rights."

POST OFFICE NEWSBRIEFS

The new international Telex service, a customer-to-customer teleprinter service, which was introduced in New Zealand on the 1st September, is available to Australia, the United Kingdom, the Republic of Ireland, Canada, the United States, Japan, Hong Kong, Malaya, Singapore, Austria, Belgium, Denmark, Finland, the Democratic Republic of Germany, the Federal Republic of Germany, Greece, Hungary, Luxemburg, the Netherlands, Norway, Spain, and Switzerland.

* * *

Mr D. E. Fouhy, C.V.O., C.B.E., official secretary to His Excellency the Governor-General, who is to retire soon, is an old Post Office man. He joined the Post Office as a cadet in the General Post Office in 1909. For a period he was private secretary to the Director-General of the Post Office.

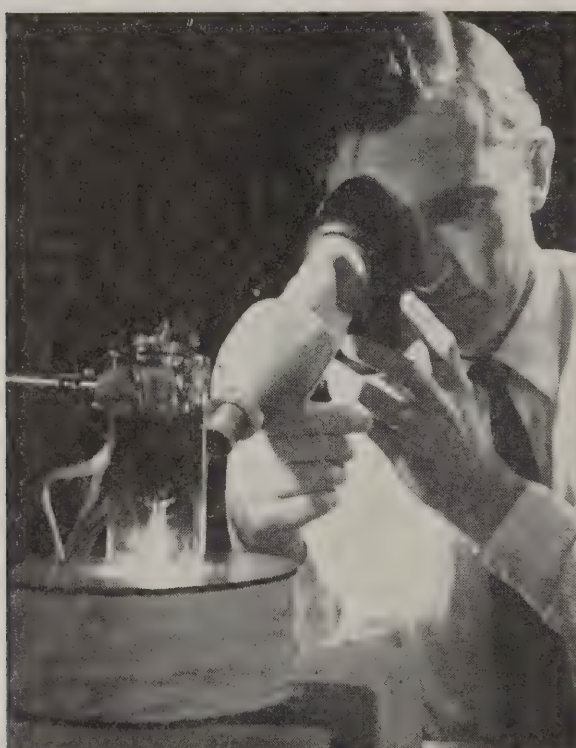
* * *

The annual report of the Post Office presented to Parliament this year was the 100th. Although the first Post Office in New Zealand was opened in 1831 it was not until 1860 that, under an Act of Parliament, the Post Office was called upon to report to Parliament. Previous to 1860, reports were made to the Governor.

LATEST OVERSEAS DEVELOPMENTS

NEW DEVICE CONVERTS LOW HEAT INTO ELECTRICITY

Princeton, New Jersey.—An important step toward development of a practical method of converting heat directly into electricity was reported recently by the Radio Corporation of America here.



THERMIONIC CONVERTER TUBE—Dr Karl G. Hernqvist of the Radio Corporation of America research laboratories in Princeton, New Jersey, examines a thermionic converter tube. The experimental tube, here suspended over a circular magnet, is capable of converting heat directly into electrical power and functions within the range of temperatures produced by ordinary fuel.

The company unveiled an experimental thermionic tube which it said produces electricity directly, without moving parts, from heat sources of 1,100 degrees Centigrade—equivalent to the temperatures produced by burning ordinary fuels, such as gasoline and natural gas—and at an efficiency of about 14 per cent.

"A major goal in work in thermionic conversion devices," according to H. W. Leverenz, director of R.C.A.'s research laboratories, "is to achieve a simple unit capable of generating electrical energy directly and with reasonable efficiency from conventional heat sources. Until now, tubes of this type have operated with acceptable efficiency only from special heat sources producing temperatures well over 2,000 degrees Centigrade. At the same time, other devices capable of operating from lower temperature sources have had the disadvantage of extremely critical construction, raising serious problems from the standpoint of economical mass-production."

The R.C.A. device is expected to help lead the way toward a wide range of applications for thermionic conversion, such as in homes, electric automobiles, nuclear reactors and in fixed and portable installations for military and industrial users. The company also is investigating conversion of solar heat for power in space vehicles.

Dr Karl G. Hernqvist, who headed the R.C.A. research team, has said that the experimental tube is capable of generating either direct or alternating current at frequencies up to about one million cycles per second. "Such units could be fabricated in various forms and arrangements to produce whatever level of power might be required," he added.

He explained the conversion principle as follows: The thermionic tube has two electrodes; one from which electrons are emitted when sufficient heat is applied, and a second to which these electrons flow to produce an electrical output. The tube is filled with cesium vapour which becomes ionized upon contact with the hot cathode, expediting the flow of electrons to the output electrode.

"In the new experimental tube," he said, "a new arrangement of internal tube elements has been conceived and a different type of cathode has been used to emit electrons at considerably lower temperatures. This permits a maximum flow of electrons without the earlier requirement for unduly high-temperature heat sources, leading in turn to longer operating life."

* * *

WESTINGHOUSE EXPERIMENTAL KITCHEN HIGHLIGHTS FUTURISTIC APPLIANCES

PITTSBURGH, U.S.A.—A unique experimental "kitchen" of the future developed by Westinghouse Electric Corporation scientists has cold cabinets instead of a refrigerator-freezer, solid cooking surfaces, a dishwasher that uses sound waves, and a combination electric and high-speed electronic oven. The kitchen, which is now on tour of the United States as part of a "Parade of the Future" exhibit, was designed to demonstrate the methods tomorrow's homemaker may use for many ordinary household tasks. It takes viewers into the laboratories to see what tomorrow will bring.

Rather than a conventional refrigerator-freezer, the kitchen employs a series of refrigerated cabinets and drawers. These are cooled to selected temperatures

(*Continued on page* 33)

ANNUAL CONFERENCE OF NEW ZEALAND RADIO & TV MANUFACTURERS

The Annual Conference of New Zealand Radio & Television Manufacturers was held at Wairakei from the 25th to 27th September, 1960. The delegates gathered on Sunday the 25th and the days of the 26th and 27th were fully occupied in business deliberations.

While there was a comprehensive agenda paper, as would be expected the centre of attention was television. Obviously all manufacturers are well forward with plans to cope for market requirements of receivers.

A further interesting point was that as an industry a real effort is being made to manufacture as many components as possible so that in the not too far distant future there will be an extremely high New Zealand content of both labour and material in locally produced television sets.

The question of the impact of television on the economy of New Zealand was discussed and from comment the impression gathered was that so far, at any rate, the advent of television had not made the slightest impact on other industries which some considered could suffer because of television.

While plans are laid for 5 kilowatt TV transmitters in Wellington, Christchurch, and Dunedin in that order, the only operational station is the relatively low powered so-called experimental transmitter in Auckland. The Conference was told that present policy was to build up transmitting hours from the present Auckland station and to operate the other stations initially on an experimental basis. There was a realization that the present low powered Auckland transmitter with an inefficient aerial was giving most inadequate coverage. Despite this sets were selling and the standard of transmissions was considered good. The Broadcasting Service had in mind a location which it was felt would admirably suit from the point of a transmission site, but problems have to be overcome in procurement of this site. There is no question that Auckland will have a first-class coverage when the projected high powered transmitter is installed in a suitable location.

Many complimentary remarks were passed regarding the efforts of the Broadcasting Service technical staff working under conditions which it was realized were far from ideal.

The industry was told that 25,000 tubes were the total allocation for all manufacturers for 1961. Provided transmission hours are extended and entertainment value of programmes is high, manufacturers in general indicated that they thought this would be insufficient to meet the market. Individual manufacturers indicated that their tube allocations did not really permit an efficient production rate, bearing in mind the number of stages required in line assembly of television sets.

As a corollary to the expansion which is expected with the advent of television, a note of anxiety was sounded on the matter of adequacy of skilled technical personnel. One speaker made the most pertinent comment that at the moment there is no distinction between the bright and the average apprentices. A most practical thought was put forward that there could be a distinction so that the bright apprentice could procure registration as a journeyman in a lesser number of hours than is provided for in the present contract.

On the final afternoon of the Conference the ladies in attendance went on a fishing trip. While the afternoon was extremely pleasant, no fish were caught, although there was one near miss.

The Conference concluded on the Tuesday night with a later dinner which was held in a generally convivial atmosphere.

The Conference was regarded, by those who attended, as highly successful.

Mr T. J. F. Spencer was elected as Federation President for the ensuing year and Mr Ralph Slade Vice-President.

A notable absentee from the Conference was Mr Martin Kimble who was on the sick list. The Conference sent him a telegram of best wishes. We understand that he is now well on the way to recovery.

WESTINGHOUSE EXPERIMENTAL KITCHEN

(*Continued from page 32*)

by means of thermo-electricity, wherein electric current passed through two dissimilar materials creates heat or cold, depending on the direction of the currents. This cooling method is silent and contains no moving parts.

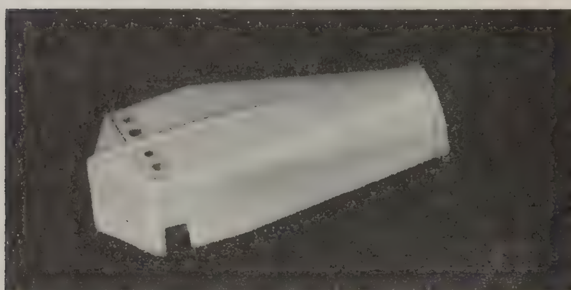
Two side-by-side drawers using thermo-electricity put frozen, fresh vegetables and meat storage between the sink and cooking area, just below work surface height. At the end of an "L"-shaped counter surface are two more deep refrigerated drawers—one a freezer, and the other a regular refrigerator section.

Above these at reach-in height is another two-way refrigerated section, with doors on either side. It is accessible from the kitchen or adjacent dining area. The electric surface cooking platforms are made completely solid rather than with the conventional cooking coils. The heating unit is cast into an inverted aluminium pan for each cooking unit, thus giving completely even heat, smooth appearance, and no place for spillage.

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. For further particulars, contact Advertising Manager, "R. & E.", Box 6361, Wellington.

PHILIPS AG 3304 DUAL-PURPOSE STEREO AND MONAURAL PICK-UP HEAD



A crystal turnover head with a diamond stylus for reproduction of stereo and monaural microgroove records and a sapphire stylus for standard 78 r.p.m. records.

Features: High channel separation, high vertical and lateral compliance, low vertical needle force, needle talk negligible, simple rapid turnover movement brings either stylus into use, stylus easily replacable, frequency response basically flat throughout the audible range.

Technical data: Output voltage, 120 mu/cm/sec.; compliance (lateral), $\geqq 73 \; 10^{-6}$ cm/dyne; compliance (vertical), $\geqq 72 \; 10^{-6}$ cm/dyne; compliance (coarse groove), $\geqq 72 \; 10^{-6}$ cm/dyne; capacity, 1500 $\mu\mu$fd.; vertical needle force, 4-6 grams; channel separation at 1000 c/s, 720 dB; needle point radius, 18 μ diamond; needle point radius, 75 μ sapphire.

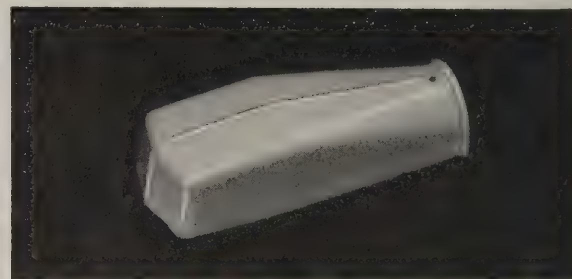
Retail price: £4 12s. 6d.

* * *

PHILIPS AG 3401 MAGNETO DYNAMIC STEREO PICK-UP HEAD

The most advanced stereo pick-up head in existence. Frequency response from 20-20,000 c/s. Output voltage strictly linear with needle tip velocity for all frequencies.

Features: High channel separation, extremely small moving mass, resonance-free reproduction of entire frequency range, needle talk negligible, proof against extreme tropical conditions, fully shielded, no magnetic stray field, constant needle pressure, no input transformer is required.



Technical data: Compliance (lateral), $\geqq 5.3 \; 10^{-6}$ cm/dyne; compliance (vertical), $\geqq 2.2 \; 10^{-6}$ cm/dyne; inductance per channel, 500 mH; D.C. resistance, 800 ohms; needle point radius, 18 μ; vertical needle force, 3-5 grams; diamond stylus; channel separation at 1000 c/s, 20 dB; at 10,000 c/s, 15 dB; effective moving mass, 3 Mg.

Retail price: £9 15s. 0d.

* * *

A.W.V. AND R.C.A. EQUIVALENTS TO JAPANESE TRANSISTORS

Many Japanese transistor types are finding their way on to the New Zealand market and the following list represents types that can be replaced with R.C.A. or A.W.V. equivalents.

Japanese No.	Similar U.S. Type	Japanese No.	Similar U.S. Type
Hitachi		Toshiba	
HJ15	2N215	2S52	2N219
HJ17D	2N217	2S56	2N270
HJ22D	2N218		
HJ23D	2N219	Ten	
HJ32, HJ70, 2S141	2N370	2S30	2N411, 2N412
HJ34, HJ34A, 2S91	2N270	2S31	2N409, 2N410
HJ35	2N301	2S32	2N405, 2N406
HJ37, HJ71, 2S141	2N371	2S33	2N407, 2N408
HJ50	2N215	2S34	2N270
HJ51	2N408	2S35	2N140, 2N219
HJ55, HJ60, 2S146	2N219	2S36	2N139, 2N218
HJ56	2N410	2S37	2N109, 2N217
HJ57	2N412	2S38	2N270
HJ72, 2S14	2N372	2S39	2N175, 2N220
HJ73, 2S143	2N373	2S40	2N269
HJ74, 2S144	2N374	2S41	2N301
HJ75, 2S145	2N544	2S42	2N301A
		2S43	2N247
Toshiba		2S109	2N370
2S44	2N217	2S110	2N371, 2N372
2S45	2N218	2S112	2N372

SOME NEW THOUGHTS ON APPRENTICESHIP

The following short paper was delivered to the recent Radio and Television Manufacturers' Federation Conference at Wairakei by Mr Fritz Wulff, of Philips Electrical Industries of New Zealand Ltd. The thoughts expressed may seem almost revolutionary, but there is some sound thinking behind them, and we hope all our readers will ponder them.

Today, 1960, we live in a world of enlightenment, of technical advance, of psychology. We accept the modern wonders of radar, television, electronics, automation, sputniks, and the like as almost commonplace. The personality, motivation, and abilities of the individual are recognized as an integral part of industrial success. And yet, the more rapidly the growth of technology advances, so does the availability of the technician diminish. Throughout the world the shortage of the trained skilled man becomes more acutely felt. What can we do about this dearth of skilled trained men?

Today, in the midst of scientific advance, we still cling to a form of training which stems from the middle ages. We still revere a form of training which is as far behind the times as is a sand clock compared to an electronic computer, or a hot-air balloon compared to a three-stage rocket. I refer to the ancient and time-honoured apprenticeship.

To become a mechanic, a serviceman, a painter or a carpenter, you must serve an apprenticeship—a period of training under a variety of skilled journeymen whose teaching can be good or bad. Whether you learn panel-heating, cabinet-making, building, pattern-making, paperhanging, or radio engineering, the time required is five years by law, no more and no less. This, in an enlightened age which recognizes individual differences, intelligence scales, and modern teaching techniques is so archaic as to be ridiculous. Can a painter require the same training time as a motor mechanic? Must a boy of high intelligence need the same training time as one of low average intelligence? The time has come when this medieval system must be replaced by modern training methods in order to meet the urgent need for skilled and qualified men.

In the Army, cadets are coached to serviceman's registration standard within twelve months for radio work. How long then to train a painter or paperhanger or panel-beater? In my own factory we can train a woman in two weeks to become a line assembler and yet an apprentice must spend a minimum of six months on this work as part of his training schedule. We also train women on alignment, repair, and testing in a matter of months and yet an apprentice must spend $2\frac{1}{2}$ years on this type of work before the law considers him properly trained in this field. We have found that a good average apprentice can qualify as a radio serviceman in 3 years and yet he must still eke out his full time before obtaining registration (provided he has turned 21). This time is not only a complete waste to both the boy and the company but his training could be completed in even less time. Let us be realistic and gear our training to the requirements of the day and use to greatest advantage the latest teaching techniques. Let us strive to abolish an ancient system which does not account for individual differences. Let us streamline our training to the capacities which we know we can achieve. Let us change a law which is completely out of touch with reality and meet our present needs with a constructive, positive approach.

This is a matter of vital concern to our industry as a whole and even critical as far as our economic and technical survival is concerned. I move, therefore, wtih complete conviction, that this conference should approach the Government with a recommendation that the present apprenticeship system should be completely reviewed with the aim of reducing its terms to at least three years, with variations to allow for the individual differences of the persons concerned.

I understand that the Electricians Registration Board has made recommendations to the New Zealand Apprenticeship Committee that trade training schools should be set up in this country. Such a procedure is adopted by many overseas countries with considerable success. Because this system gives concentrated theoretical training with adequate practical work, this conference should seriously consider giving it full support. It is only by these measures that we can make certain of a future supply of trained men.

METALLIZED CAPACITORS

(*Continued from page* 14)

falling between 1000 and 4000 ohm.farads at room temperature. The lowness of the claimed figures is not in any way due to difficulties in obtaining higher values but is rather a function of the time taken to pass large quantities of components through tests for higher limits, since the testing-time increases with increasing insulation resistance pass-limits. Now that there is increasing use of automatic test equipment, this position is changing and eventually a more realistic pass-limit will be applied so that a clearer picture of the true quality of the metallized paper capacitor will emerge.

AN INTRODUCTION TO TELEMETRY

(*Continued from page* 18)

Of the three possibilities, the third is the best, in that it frees a higher-frequency channel, which can then be used to handle rapidly changing modulation that cannot be "juggled" with in the same way as above. On the other hand, each step in reducing the modulation frequencies so as to use lower channels requires more equipment and increases the possibility of failure.

A sub-carrier oscillator must be capable of being modulated in a linear fashion. It must have good stability and little distortion, and since space and weight are always at a premium, simple basic circuits are often used. In order to achieve these aims, high-grade close-tolerance components must be used throughout the equipment, and construction must be according to the highest standards. It is not always possible to reduce frequency drift as much as is desired, so that frequent calibration is often required. This can be done, for example, by switching off the modulation from time to time, and measuring the free-running frequency of the oscillator. Corrections can then be made according to the drift found from the nominal free-running frequency.

AN EXPERIMENTER'S TELEVISION RECEIVER

(*Continued from page* 21)

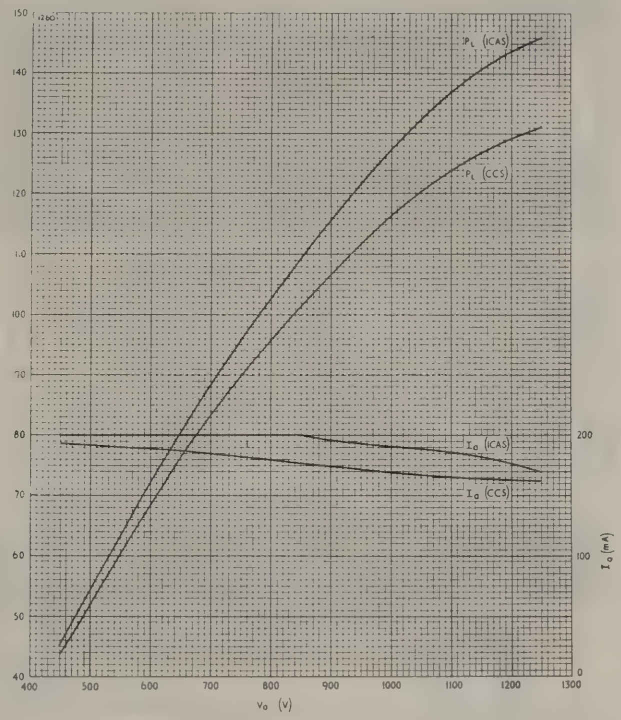
triode section is taken to the tapping point, because it needs less bias than the output section does. Apart from the use of a double tube, the circuit is quite conventional and requires little comment. It is obviously not designed for high-fidelity, and should one want to make the most of the excellent quality that can be obtained from the TV sound, the output of the EQ80 can be fed to a high-quality amplifier and speaker system, and the ECL80 omitted altogether from the circuit. Alternatively, it can be included for the sake of completeness, and a closed-circuit jack used at the output of the EQ80 for leading out the audio signal when required.

Next month, we will give the circuit of an R.F. amplifier and oscillator-mixer stage suitable for receiving Channel 6. This will be wanted by those who are within range of any of the various experimental stations that are on the air in different places, while those who want to receive Channel 2, for the Auckland transmitter, can duplicate the tuner section of our previous receiver, which will be found described in the August, 1959 issue.

TT21 AND TT22

(*Continued from page* 28)

capabilities, and we have been asked to inform readers that full data and information will be supplied on request to the British General Electric Co. Ltd., Wellington.



Class C telegraphy. Power output/anode voltage curves.

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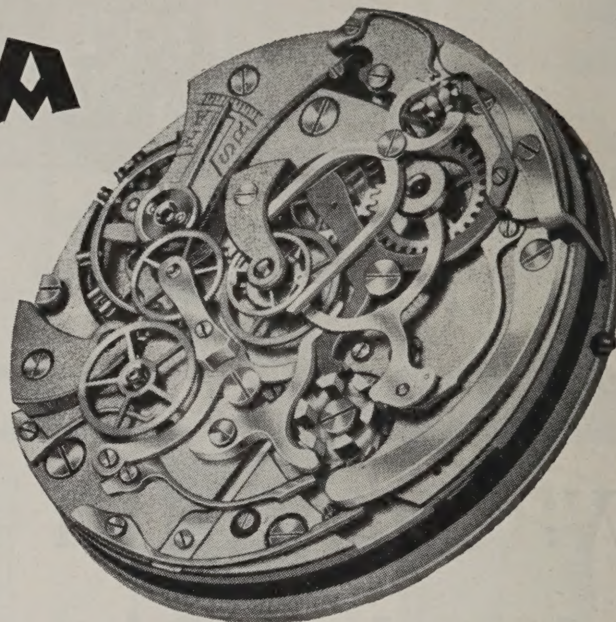

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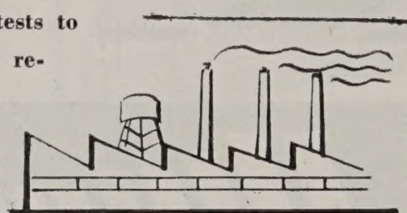

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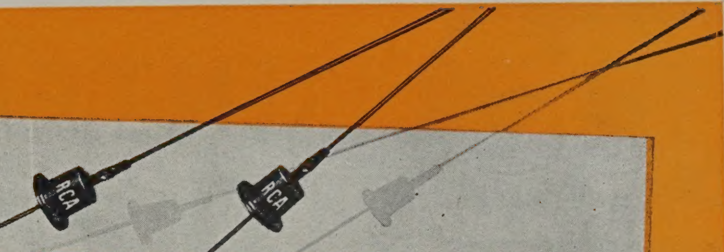

DIFFUSED-JUNCTION TYPES

7 Types for INDUSTRIAL and MILITARY power supplies

Maximum Ratings, Absolute-Maximum Values: For supply frequency of 60 cycles and with resistive or inductive load

RCA TYPE NUMBERS	Peak Inverse Voltage (VOLTS)	RMS Supply Voltage (VOLTS)	DC Reverse Voltage (VOLTS)	FORWARD CURRENT, DC: 50°C Ambient (MA)	100°C Ambient (MA)	150°C Ambient (MA)	Surge One-Cycle (AMP)	AMBIENT TEMPERATURE: Operating (°C)	Storage (°C)	CHARACTERISTICS at Ambient Temp. of 25°C: Max. Forward Voltage Drop (DC) at indicated DC Forward Current (VOLTS)	Max. Reverse Current (DC) at Max. Peak. Inverse Voltage (μa)	at Ambient Temp. of 150°C: Max. Reverse Current (averaged over one complete cycle) at Max. Peak. Inverse Voltage (μa)
IN536	50	35	50	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	400
IN537	100	70	100	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	400
IN538	200	140	200	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	300
IN539	300	210	300	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	300
IN540	400	280	400	750	500	250	15	−65 to +165	−65 to +175	1.1 at 500 ma	5	300
IN1095	500	350	500	750	500	250	15	−65 to +165	−65 to +175	1.2 at 500 ma	5	300
IN547	600	420	600	750	500	250	15	−65 to +165	−65 to +175	1.2 at 500 ma	5	350

2 Types for TV and GENERAL PURPOSE applications.

Maximum Ratings for supply frequency 60 cycles and with capacitor input.

R.C.A. Type Numbers	Peak Inverse Voltage (Volts)	RMS Supply Voltage (Volts)	FORWARD CURRENT D.C.: Up to 75°C (MA)	Peak (MA)	Surge (AMPS)	AMBIENT TEMPERATURE: Operating (°C)	Storage (°C)	Maximum Reverse Current (uA)
IN1763	400	140	500	5,000	35	100	—65 to +150	100
IN1764	500	175	500	5,000	35	100	—65 to +150	100

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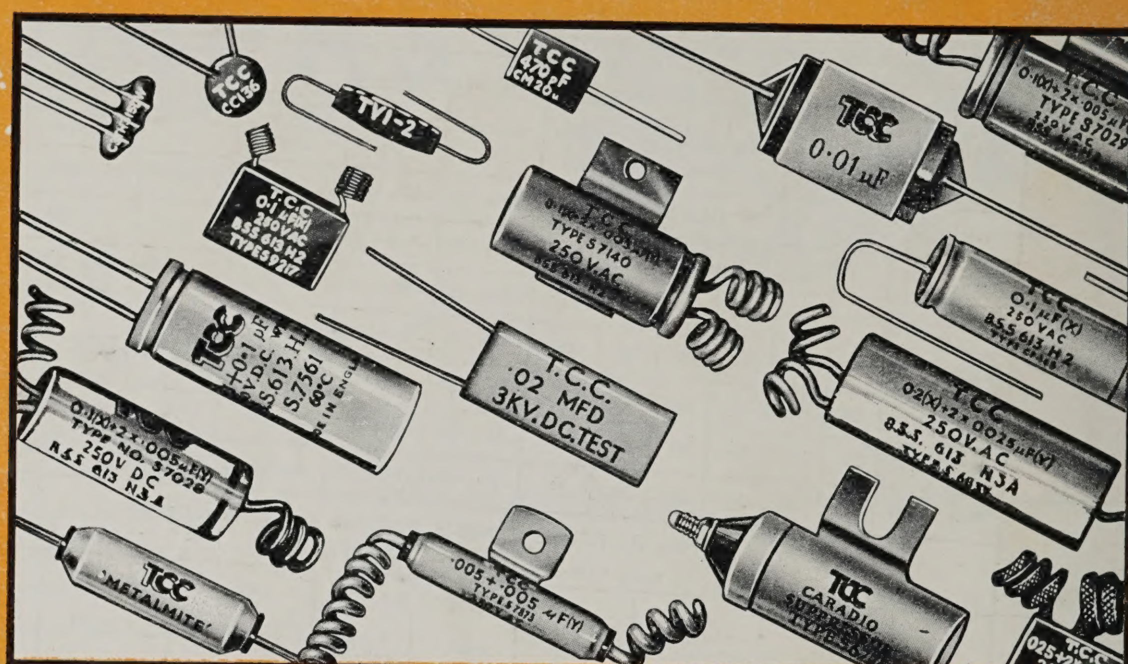
INTERFERENCE SUPPRESSORS



T.C.C. components and typical suppression circuits enable manufacturers and service engineers to deal effectively with the suppression of electrical interference in a wide variety of appliances.

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